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# Relations between impulsivity and mindfulness in adolescents with behavioural, emotional and social difficulties

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**Relations between impulsivity and mindfulness in  
adolescents with behavioural, emotional  
and social difficulties**

by

**Jessica Claire Bradford**

A thesis submitted to the University of Plymouth  
in partial fulfilment for the degree of

**Doctor of Philosophy**

School of Psychology  
Faculty of Science & Technology

In collaboration with Great Western Research  
and *Removed to ensure participant confidentiality (co-sponsor details can be  
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**May 2012**



Jessica Claire Bradford

Relations between impulsivity and mindfulness in adolescents  
with behavioural, emotional and social difficulties

**Abstract**

Impulsivity and the effectiveness of a mindfulness-based intervention were explored in relation to improving behavioural self-regulation in adolescents with behavioural, emotional and social difficulties (BESD). A computerised choice task (CCT) was developed to measure delay discounting (a shift in choice from a larger reward to a smaller reward as the delay to the larger reward increases) in adolescents with BESD and compared it with several additional measures of impulsivity. The degree to which impulsivity and thoughts are related was explored using mindfulness measures. Effects of task type (computer versus sand-timer) and task context (school versus house) were also studied. Results suggested an effect of method but not location on discounting. Few between measure comparisons were significant, suggesting the possibility that different impulsivity measures assess different forms of impulsivity. However a significant negative correlation was found between impulsivity and mindfulness. A mindfulness-based intervention was implemented and results suggest potentially beneficial effects of applying mindfulness training to improve self-control and self-regulation in adolescents with BESD. Further research is necessary to determine the effectiveness of mindfulness training in adolescents with BESD, and explore differences between impulsivity measures to assist with effective measurement and intervention.

*Keywords:* Impulsivity, Self-regulation, Thoughts, Intervention, Mindfulness, Delay discounting, Adolescents, BESD.



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At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

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## **Chapter 1**

### **Literature Review**

#### **1.1 Introduction**

Special schools provide placements, some of which are residential, for a proportion of pupils who have difficulty accessing mainstream educational and social settings. The work reported in this thesis arose from an opportunity to collaborate with a special education provider for young males between the ages of 11 and 19 years who had Behavioural, Emotional and Social Difficulties (BESD), with complex special education needs (SEN) and associated challenging behaviour (reviewed in more detail in section 1.2 of the current chapter).

Despite the availability of effective school behaviour policies, personal/social curriculum and multi-disciplinary approaches (involving Psychologists, Cognitive Behaviour Therapists, Speech and Language Therapists, Physiotherapists, and Occupational Therapists), schools frequently encounter difficulties with the challenging behaviour exhibited by adolescents with BESD.

A variety of approaches are used in attempts to manage the behaviour of pupils with BESD. For example, these can include interventions based on behavioural, cognitive, psychodynamic, systemic and biological approaches (Frederickson & Cline, 2003). The behavioural approach considers that much behaviour is a product of experience and environment. Attempts to alter behaviour have been made by changing events or consequences in the environment. One example of this is the token economy (Ayllon & Azrin, 1968), whereby individuals can earn

tokens (such as money, marbles, or stickers) for desired behaviour. They can exchange these later for goods, services, or privileges. The aim is to provide an environment in which desirable behaviour is supported and undesirable behaviour is not supported (Martin & Pear, 2007).

However, designing a token economy involves considerable planning and organisation as consistency and control are fundamental to its success. For example, target behaviours and location need to be decided; token type, number and frequency and backup reinforcers selected; staff identified and trained to collect data and arrange contingencies of reinforcement and punishment (Martin & Pear, 2007). Therefore, tailoring token economies to suit each individual student in terms of individualised targets based on areas of difficulty and type of reinforcer is important. Even then, sources of reinforcement and punishment outside of the token system might have a greater effect on behaviour than those controlled by the managers of the economy. In short, despite evidence of success in changing behaviour, operating a successful token economy is a difficult task and the system may not always be implemented as effectively as it might be (Kazdin & Bootzin, 1972).

The cognitive approach (Beck, 1989) focuses on the ways in which individuals perceive, think, plan events, and solve problems. The relation between such cognitions and environmental events is assumed to govern the way in which an individual interprets an event and behaves. For example a friend ignores you on a second occasion when they pass you in the street, so you arrive at the thought that they dislike you, rather than some other reason unrelated to you, and become angry when you next see them.

To modify behaviour the cognitive approach aims to alter how individuals think about themselves and the environment through re-labelling, self-talk strategies. For example, the therapist suggests strategies to cope with feelings or physiological indicators of anger or anxiety, such as sweating hands and a pounding heart (Frederickson & Cline, 2003). A possible advantage of this over a token economy is that it is less dependent for success on extended periods of observation and on the coordination of several staff or carers. Effectively, the person is taught to regulate their own behaviour through conscious thought rather than relying on environmental contingencies.

The success of this approach clearly depends on an individual's capacity to be aware of their own thoughts. It seems reasonable to suppose that the capacity to be self-aware varies from individual to individual, and may be attenuated in the case of some groups who might otherwise benefit from cognitive therapy or CBT. For example, staff providing psychological therapies at the school in which the current research was carried out, raised concerns that cognitive interventions were often ineffective because students were unable to articulate thoughts and feelings, and had difficulties evaluating and reflecting on their own behaviour.

One group in which there may be particular grounds for questioning whether awareness of thoughts might be attenuated is individuals with Autism Spectrum Disorder (ASD). Individuals with ASD are commonly reported to present an inefficient or delayed Theory of Mind (ToM), whereby they have difficulty understanding the feelings and beliefs of others (Baron-Cohen, 2008; Premack



& Woodruff, 1978), and some ASD research has reported a more generalised deficiency in ToM regarding the attribution of mental states to self and others (Frith & Happé, 1999; Burton & Mitchell, 2003).

According to Frith and Happé (1999), “without self-awareness, an individual might not know how she is going to act until she acted, nor why she acted as she did” (p. 8). Such a deficiency might contribute to seemingly uncontrollable, impulsive behaviour (defined as “acting or done without forethought”, Impulsivity, Oxford dictionaries online, 2010) in individuals with ASD.

Frith and Happé (1999) and Thompson (2008) however, suggest that high functioning individuals with ASD or Aspergers Syndrome can effectively develop the ability to attribute mental states to self and others through effortful learning or early intervention programs. This seems to imply that self-awareness (the awareness of one's own private events such as thoughts) might be a skill that could be taught. If it is, it seems reasonable to consider whether increasing self-awareness might enable more effective application of therapeutic interventions that depend on the awareness of one's own thoughts. The development of greater self-awareness could open the door to the effective use of cognitive therapies and, through these, foster self-regulation and consequent improvements in behaviour.

Therefore, the intention of this work was to study the relationship between the regulation of behaviour and self-awareness to determine whether methods aimed at developing self-awareness as a skill would lead to an improvement in self-regulation and desirable behaviour in individuals with BESD.

## **1.2 Behavioural, Emotional and Social Difficulties (BESD)**

Cooper (1996) identified BESD as “any problem of an emotional or behavioural nature that is experienced by a young person to an extent that it interferes with their personal, social and/or educational development... to include psycho-social problems, such as socialised deviancy and delinquency; low self-esteem, anxiety, withdrawn and acting out behaviour. We also see it as falling under ...problems of a broadly bio-psychosocial nature, such as those associated with ADHD (*Attention Deficit Hyperactivity Disorder*), Autism and related conditions” (p. 1).

According to a recent article on [teachernet.gov.uk](http://teachernet.gov.uk) (2009), pupils may range in ability, but should only be recorded as BESD if it is their primary or secondary SEN and they have a statement, or are at 'School Action Plus' (where additional support at the 'School Action' stage has failed to help the child make adequate progress, and external advice/support is required). Advice produced by the Department for Children Schools and Families (DCSF, 2008) stated that "children and young people with BESD have SEN if they have a learning difficulty that calls for special educational provision, that is provision that is additional to or different from provision that is generally available" (p. 4).

The DCSF report states that BESD covers a wide range of SEN, including conduct disorders (such as Oppositional Defiant Disorder, ODD), hyperkinetic disorders (such as Attention Deficit Disorder, ADD, and Attention Deficit Hyperactivity Disorder, ADHD), emotional disorders, anxiety, self-harm, school phobia, and depression. It also includes children and young people not

medically diagnosed, but whose behaviour or emotional well being are deteriorating. Learning difficulties can additionally exacerbate BESD. As cited in the DCSF report, the Disability Discrimination Act (1995) states that an individual has a disability if they have "a mental or physical impairment that has a long-term and substantial adverse effect on their ability to carry out normal day-to-day activities". Day-to-day activities include "memory or ability to concentrate, learn or understand" (p. 12).

Recognition for a having BESD depends on the nature, frequency, persistence, severity and the abnormality of the difficulties and the effect the difficulties are having on the individual's behaviour and emotional well being in comparison to that of an individual of the same age. According to the SEN code of practice (cited in the DCSF report), BESD is a learning difficulty where individuals display features of behavioural and emotional difficulties such as "being withdrawn or isolated; disruptive and disturbing; being hyperactive and lacking concentration; having immature social skills; or displaying challenging behaviours arising from other complex special needs" (p. 12). These difficulties can result in learning difficulties, as they affect individuals' ability to cope with school routines and social relationships, and may cause a barrier to learning.

According to the DCSF guidelines, BESD is more prevalent in socially deprived areas and in young males. In 2008, over 60 percent of children and adolescents in Pupil Referral Units (PRUs) have SEN and many of these have BESD. If not given the necessary support, individuals with BESD can miss out on opportunities that occur naturally for peers. In accordance with the Every Child Matters guidelines, 2004 (be healthy, stay safe, enjoy and achieve, make a

positive contribution and achieve economic well being), the DCSF report recommends early intervention with a highly structured, responsive and individualised approach to working with individuals with BESD. They advise targeted support with emphasis on personal development and essential life skills, in addition to informative progress monitoring and evaluation of outcomes. Although it is not necessary for an individual to have a medical diagnosis to be identified as having BESD, a diagnosis can be useful in identifying appropriate management strategies.

As mentioned by Cooper (1996), individuals with BESD could include those with a diagnosis of ASD (Autism Spectrum Disorder). Autism Spectrum Disorder is characterised by social interaction and communication impairments, and restricted repetitive, stereotyped patterns of behaviour, interests and activities, including inflexibility of routines (DSM-IV-TR, 2000). The DSM-IV-TR maintains that individuals with ASD “may have a range of behavioral symptoms, including hyperactivity, short attention span, impulsivity, aggressiveness, self-injurious behaviors, and, particularly in young children, temper tantrums” (p. 72).

The DSM-IV-TR identifies ADHD and ASD characteristics to include inattention, hyperactivity and impulsivity. As a core characteristic of a substantial proportion of pupils with BESD (i.e. individuals with ADHD and/or ASD), it is reasonable to propose that impulsivity poses a hindrance to the effective regulation of behaviour in individuals with BESD. In light of the literature reported in section 1.1 (e.g., Frith and Happé, 1999; Thompson, 2008), it might be possible to improve self-regulation in adolescents with BESD through improving their self-awareness.

Baumeister, Vohs and Tice (2007) maintained that the terms self-regulation and self-control are commonly used interchangeably, with inadequate self-control having been associated with problems of impulse-control. In response to this, one approach to assessing effective regulation of behaviour is to measure impulsivity. The following sections of the current chapter explore literature on impulsivity, self-control and self-awareness.

As indicated by Cooper (1996) and in the DCSF report (2008), children and adolescents with BESD have a wide variety of associated diagnoses, and consequently present many and varied characteristics and difficulties. In addition, since the present project involved collaboration with a specific education provider at a particular school for young males with BESD, it was not possible to select specific groups of individuals on which to carry out research. Consequently, although the large variability was likely to raise problematic issues with regard to variability within data and a lack of control regarding participant selection criteria, working with a mixed sample of young males with BESD was unavoidable.

### **1.3 Impulsivity**

Humans and animals are regularly presented with situations involving choice between options varying in size, delay or certainty (Green & Myerson, 2004).

Impulsive choice has been described as the tendency to choose more immediate smaller rewards over larger rewards available after a delay (Ainslie, 1975). Self-controlled choice, often referred to as the opposite of impulsivity (Mitchell, 1999; Bickel & Marsch, 2001), has been defined as the choice of a

larger delayed reward over a more immediate less rewarding option (Rachlin & Green, 1972).

As will become clear in the present chapter, research suggests both humans and animals frequently choose the more impulsive, less rewarding option. According to McCown, Johnson and Shure (1993), highly impulsive behaviour can be characterised as a preference for immediate and easy self-gratification and shorter response times. To further understand and attempt to explain such behaviour, the current chapter explores previous research on impulsivity and self-control.

The study of choice is an area where many psychologists, economists, sociologists and psychiatrists (see Ainslie, 1975) have focussed much attention due to its broad application to behaviour. Choices are made frequently in everyday situations (such as whether to buy a cheap item immediately or save for a better more expensive one later; Green & Myerson, 2004) and are important determinants of future events. Such research has focused on both behavioural and cognitive aspects (Rachlin, Logue, Gibbon, & Frankel, 1986) and has included the study of a large variety of populations.

Ainslie (1975) reviewed various explanations for why individuals make impulsive choices. Selected examples included deficient learning of alternatives, ignorance, Freud's "pleasure principle", and effects of delay to reward accessibility. Neuropsychological research by McClure, Laibson, Loewenstein and Cohen (2004) produced evidence that two separate neural systems were involved in making decisions between more immediate and delayed monetary

amounts. In addition, although not discussed in detail here, the behavioural economic literature is also becoming increasingly substantial (see Frederick, Loewenstein & O'Donoghue, 2002; Berns, Laibson & Loewenstein, 2007).

Green and Myerson (2004) argued that choice was simple in the presence of one reward dimension. For example, most organisms would choose a large reward rather than a small reward, and an immediate reward over a delayed reward. However, choice options involving more than one dimension, such as those varying in delay and size, produce varied responses. When presented with an immediate reward and a delayed reward of equal value, organisms typically choose the former, however when the value of either reward is altered, organisms' choice changes. Such choice behaviour has been described as *delay discounting*: "a smaller, more immediate reward may be chosen because the present (or subjective) value of the larger, more delayed reward is discounted; hence, its present value may be less than that of the more immediate reward" (Myerson & Green, 1995, p. 263).

Green and Myerson (1996) noted that animals are repeatedly required to make choices between smaller immediate rewards (i.e. a small prey now) and larger delayed rewards (i.e. a large prey later). They emphasised the likely effect of risk in making such decisions, whereby as the delay to the larger reward increases, responses to that reward decrease. In support of this, Rachlin and Green (1972) found that pigeon chose an immediate small reward (2 seconds access to food) over a larger reward (4 seconds access to food) available after a delay of 4 seconds. Furthermore, choice was affected by the amount of delay to both a smaller more immediate and larger more delayed reward. Specifically,

with a large amount of time to wait for the small reward and even longer to wait for the large reward initially, pigeon chose the larger reward. However, as the amount of time to the smaller reward decreased, pigeon changed their choice to the smaller reward. Similarly, Green and Snyderman (1980) reported findings to suggest that pre-reward delay affected choice more than reward amount.

The relation between human and animal choice responding has been highlighted through similarities in findings in both human and animal studies. For example, similar results to those described above were reported in a human choice study by Sonuga-Barke, Lea and Webley (1989c). Furthermore, research involving human choice between two delayed rewards (Green, Myerson & Macaux, 2005) indicated that discounting decreased as the delay to the more immediate reward increased. A review by Ainslie (1975) led him to propose such a shift in preference as a "function of elapsing time" (p. 464), whereby the present value of rewards decrease as delays increase. Choice research has repeatedly found evidence that both humans and animals frequently respond impulsively. That is by discounting a larger delayed (larger later, LL) reward for a smaller, more immediate (smaller sooner, SS) alternative. This has been accompanied by attempts to develop theoretical accounts of inter-temporal choice. We will now examine measures of delay discounting and present literature regarding quantitative accounts of discounting.



## 1.4 Indifference Points and Discount Functions

### 1.4.1 Indifference points

The desire to quantify and predict choice between rewards of different delays and sizes has generated a major area of research. Several adjusting procedures (discussed later in the present chapter) have been developed to obtain indifference points (IPs). These are points at which an individual is indifferent between two rewards differing in, for example, size and delay. A single IP indicates the present (discounted) value of a reward at a specified delay.

For example, the hypothetical data in Figure 1.1 show that when given a choice between £10 available after waiting 1 week and £1 available immediately, this individual would choose to wait 1 week for the £10. However, as the more immediate reward increases in size, it becomes increasingly more likely that the individual will choose the smaller sooner (SS) reward and the likelihood of the individual choosing the larger later (LL) reward declines to a point at which the individual is indifferent between the two reward options (i.e. the subjective value of both SS and LL are equal). This point is known as the indifference point (IP). Similarly, as delay to the LL reward increases in Figure 1.2 the LL decreases in subjective value and the relative subjective value of the SS option increases to a point at which subjective value of both LL and SS are equal: the IP.

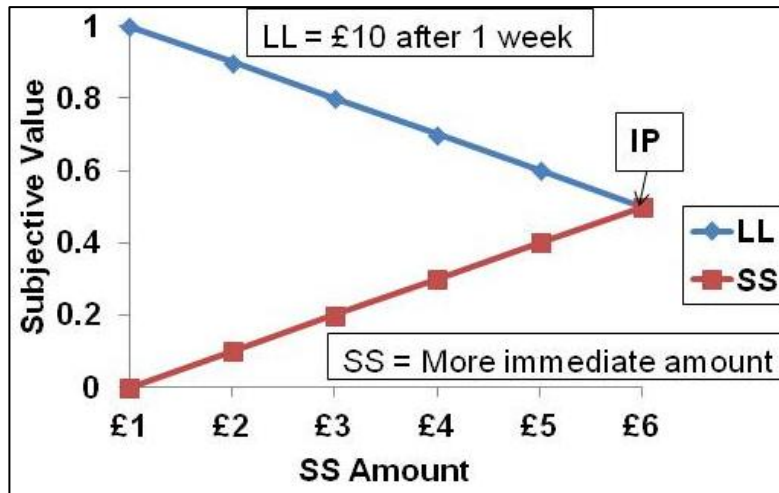


Figure 1.1 Hypothetical subjective values of the larger later (LL) and smaller sooner (SS) reward options as the SS reward amount is increased and LL is fixed.

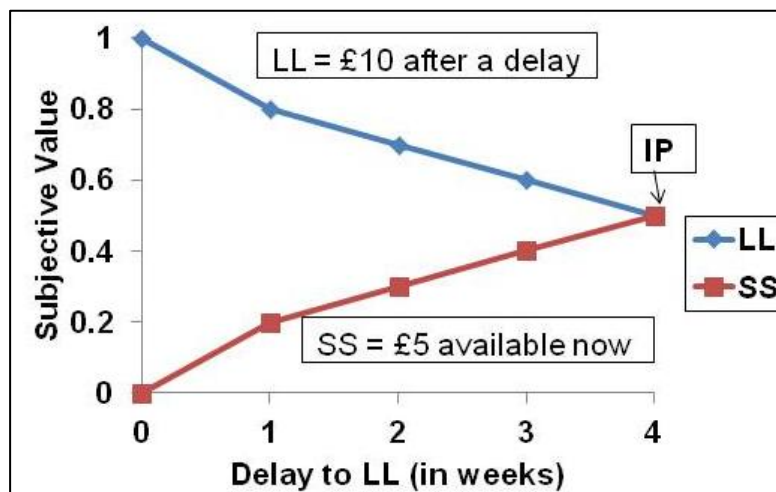


Figure 1.2 Hypothetical subjective values of the larger later (LL) and smaller sooner (SS) reward options as the delay to the LL reward (£10) is increased and SS is fixed.

Adjustment procedures (section 1.5) are regularly used in experimental studies of choice to increase and decrease (depending on the participant's previous choice) the more immediate (SS) reward values in order to converge on an

individual's IP. The IP is a function of choices made by a participant and these choices are reflected in the SS rewards presented on subsequent trials. Plotting the SS values can therefore provide an indication of participants' choices throughout a specific delay. These SS reward values can be used to calculate IPs by means of several different methods (described later).

However, it is important to note that it is possible for participants to only choose SS reward values or only choose LL reward values throughout a series of choice trials. For example, total SS responding could occur when the delay was excessively large for the participant to want to wait, or the LL reward amount was excessively small for the participant to want to wait for it. On the other hand, total LL responding could occur if the delay was not large enough in comparison to the subjective value of the reward amount. This is called a *corner solution* and criteria can be set in the event that this occurs (e.g., in the Green et al. IP Method described below). The number of choice trials necessary to calculate an IP may vary, for example, if there is a requirement for consistent responding, or fixed, depending on the adjustment procedure (see section 1.5) used.

#### **1.4.1.1 Calculating IP from consistent responding.**

Some methods present each participant with a variable and unpredictable number of choice trials because the IP is only obtained when participants have repeatedly chosen and rejected the same, or similar, SS and LL rewards on consecutive trials. As will be discussed in more detail later, it could be argued that, while such methods may identify IPs reliably, they could be time

consuming and bring risks to validity such as fatigue effects caused by the presentation of potentially large numbers of similar choice options.

#### 1.4.1.1.1 Coffey et al. IP method.

For example, one method requiring consistent choice responding was employed by Coffey, Gudleski, Saladin and Brady (2003). Coffey et al. presented rewards in ascending and descending order, and when participants' preferred reward changed from the SS reward to the LL reward, the value of the last SS reward chosen was recorded as the IP (Figure 1.3). It was necessary for the LL reward to be chosen four consecutive times within a time delay for that trial to be discontinued. This was repeated with the same reward for each of 16 time delay conditions.

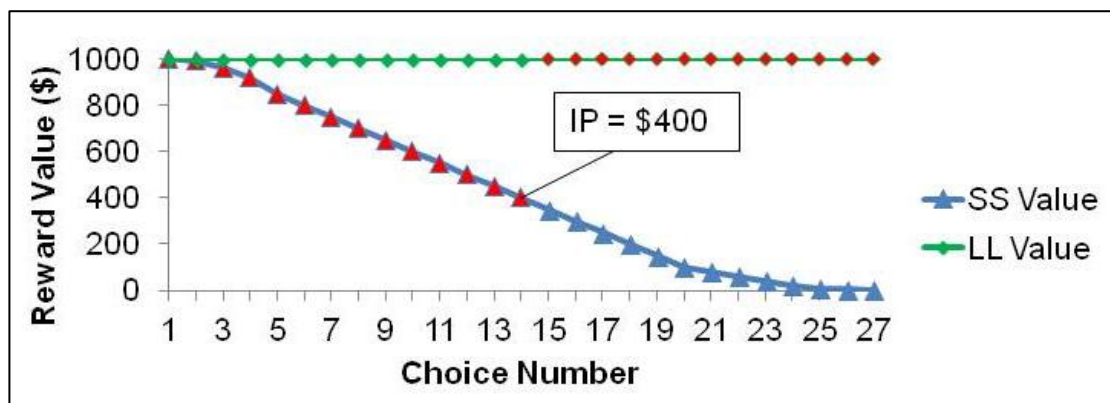


Figure 1.3 Values of larger delayed (LL) and more immediate (SS) hypothetical rewards presented in Coffey et al. (2003). Chosen rewards are highlighted red.

#### 1.4.1.1.2 The Double-Limit IP method.

Crean, de Wit and Richards (2000) and Reynolds, Ortengren, Richards and de Wit (2006) used the Double-Limit adjusting procedure developed by Richards, Zhang, Mitchell and de Wit, 1999 (see section 1.5), that involved a varied

number of choice trials depending on participants' choices. Larger later (LL) rewards were fixed and SS rewards were adjusted depending on participants' previous choices by increasing or decreasing upper and lower limits (discussed in more detail in section 1.5.5). Each SS value was selected from the range of values between the upper and lower limits, which narrowed until the difference between the maximum upper and lower limits was \$0.50 and participants responded consistently. For each delay, the IP was recorded as the value of SS after the SS reward had been chosen equally as often as the LL reward. The number of choice trials from which the IP was obtained therefore varied between participants.

#### ***1.4.1.2 Calculating IP from a fixed number of trials.***

Some methods used to estimate IPs use a fixed number of choice trials in conjunction with an adjustment procedure to converge on a point at which LL and SS are of equal subjective value. The number of trials can differ between tasks depending on the adjustment procedure used. Fixing the number of trials can be beneficial in estimating the session duration, and the adjustment procedures that require small numbers of trials are less time consuming and have a lower risk from effects of fatigue. Nevertheless, without the requirement for consistent responding, it is possible that IPs obtained in this way lack validity because individuals are forced towards their IPs (see section 1.5.6).

In studies involving a fixed number of choice trials, IPs have been calculated as the proportion of choices for the LL reward (e.g., Solanto et al., 2001; Fox, Hand & Reilly, 2008; Hoerger & Mace, 2006), but with small fixed rewards of, for example an SS of 1 token and an LL of 2 tokens across successive delays.

#### *1.4.1.2.1 The Bickel et al. IP method.*

Bickel, Odum and Madden (1999) randomly presented reward values to participants, but later ordered SS values into ascending and descending orders. From these, Bickel et al. calculated the IP as the average between the last immediate amount chosen in the descending order and the first immediate amount chosen in the ascending order for each delay. Similarly, Dixon, Marley and Jacobs (2003) calculated the IP at each delay as the average between the last immediate amount chosen of the ascending rewards and the first immediate amount chosen of the descending rewards.

#### *1.4.1.2.2 The Green et al. IP method.*

The Green et al. IP Method (Green, Myerson & Macaux, 2005) involved a fixed number of choice trials and an adjustment procedure to alter the SS reward amount depending on participants previous choices. Green et al. calculated the IP for each delay as halfway between the largest SS reward preferred over the LL reward and the smallest SS reward preferred over the LL reward. However, if a participant made a corner solution by choosing LL rewards in all trials, the IP of LL was calculated to be halfway between the last SS reward value presented and the maximum amount (i.e., the LL value); if a participant made a corner solution by constantly choosing the SS reward in all trials, the IP of LL was calculated as halfway between the last SS reward value presented and the minimum amount (i.e., zero).

For example, in Figure 1.4 (using hypothetical data) the largest SS reward value chosen over LL (£10) was £10 and the smallest SS reward chosen over LL was

£6. Consequently, according to the Green et al. IP Method, the IP for this individual at this delay would be £8. Therefore, one could say that for this participant, £10 available after a delay (e.g., of 1 week) is equal to £8 available immediately.



Figure 1.4 Example of more immediate (SS) values (hypothetical) presented during a single delay condition with chosen SS rewards in red.

#### 1.4.1.2.3 The Du et al. IP method.

The Du et al. IP Method (Du, Green & Myerson, 2002) involved a similar method to Green et al. (2005). A set number of choice trials (six) were presented to participants and an adjustment procedure was used that increased and decreased the more immediate rewards, values converge on a point of indifference. Du et al. calculated the IP as the midpoint between the last immediate amount chosen and the last immediate amount rejected. Using hypothetical data in Figure 1.5, the IP would be calculated as £53.91.



Figure 1.5 Example of delayed (LL) reward values and immediate (SS) reward values (hypothetical) presented during a single delay with participants choices highlighted red.

#### 1.4.1.2.4 The Mitchell IP method.

Similarly, Mitchell (1999) arranged choice items in descending order and items were coded according to participant's preferences for a Standard (LL) or Alternative (SS) reward. The IP was recorded for each delay condition as halfway between the lowest SS value preferred and the highest SS rejected.

Consensus on the most accurate method of obtaining and calculating IPs is absent. However, as mentioned previously in the current section, methods for calculating IPs depend on the adjustment procedure used. As will be argued later in the present chapter and within experimental chapters, different adjustment procedures have disadvantages and benefits depending on the choice task (CT) and participants receiving the task.



### 1.4.1.3 Indifference curves.

To illustrate the rate at which organisms discount delayed rewards, a series of indifference points can be obtained across several delays and plotted to create an indifference point curve. Figure 1.6 illustrates two different patterns of indifference points. The first (left) shows typical discounting, as described previously, where the value of a larger reward decreases as the delay to it increases. The second pattern (right) shows no discounting, but a corner solution (section 1.4.1) whereby choices to the LL reward are made throughout, leaving responses to the SS reward at zero (it is possible for this to occur vice versa: responses to the SS reward are made throughout, leaving responses to the LL reward at zero).

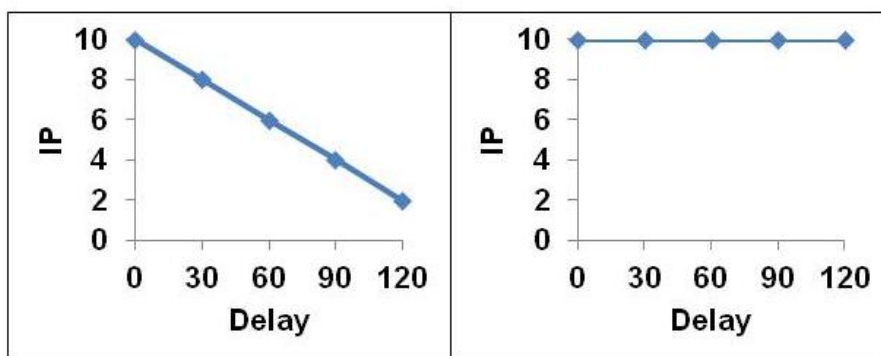


Figure 1.6 Patterns of indifference point plots showing discounting and a corner solution (hypothetical data).

### 1.4.2 Discount functions

A number of methods have been employed to predict discounting across several delays. A common approach taken by economists to predict discounting of delayed outcomes is to apply an exponential discount function (e.g., Samuelson, 1937). However, many psychologists have found that an alternative

hyperbolic discount function (Equation 1) provides a better fit for discounting data, accounting for the variation of data obtained at both group and individual level (Green & Myerson, 2004), for example Mazur (1987), Johnson and Bickel (2002), Coffey, Gudleski, Saladin and Brady (2003), Ho, Wogar, Bradshaw and Szabadi (1997), Green et al. (2005), Rachlin, Raineri and Cross (1991) and Simpson and Vuchinich (2000):

$$Y = A / (1 + bX)^s$$

where  $Y$  is the subjective value of a reward of amount  $A$ ,  $b$  is the discounting rate parameter,  $X$  is the independent variable (i.e. delay until receiving the reward), and  $s$  reflects the nonlinear scaling of amount and time.

According to Ainslie (1975) "impulsiveness seems to be best accounted for by the hyperbolic curves that have been found to describe the decline in effectiveness of rewards as the rewards are delayed from the time of choice" (p. 463). Using a hyperbolic-like function, curves can be produced from which a present reward value may be predicted across different delays or reward sizes. Indifference points obtained from a discounting task can be plotted and compared to those predicted by a hyperbolic discount curve to determine the extent to which the data fit.

Similar hyperbola-like functions have also been reported, such as the power transformation (Myerson & Green, 1995) and area under the curve (Myerson, Green & Warusawitharana, 2001). Calculating the area under the discount curve (see Figure 1.7) provides a measure of the rate at which an organism discounts a series of delayed rewards: the smaller the area under the curve, the steeper the rate of discounting. Empirical (actual, observed) values are plotted

(rather than predicted values plotted using the hyperbolic discount function) and delay and subjective values are normalised (delay is calculated as a proportion of the maximum delay and subjective value is calculated as a proportion of the large delayed amount). According to Myerson et al. (2001), the area under the curve provides a simple measure of discounting that avoids the limitations of using inferential statistics and problems produced by the exponential and the hyperbolic discount functions.

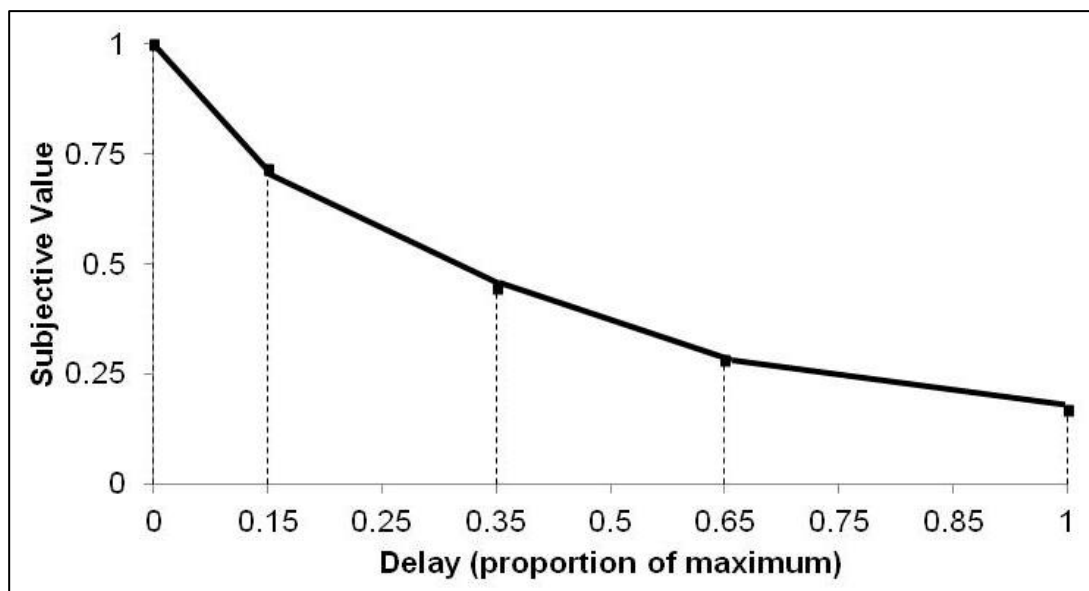


Figure 1.7 Example of a series of indifference points plotted and subdivided into trapezoids to calculate the area under the curve.

The area of each trapezoid is calculated using  $(x_2 - x_1) [(y_1 + y_2) / 2]$ , "where  $x_1$  and  $x_2$  are successive delays, and  $y_1$  and  $y_2$  are the subjective values associated with these delays. (For the first trapezoid the values of  $x_1$  and  $y_1$  are defined as 0.0 and 1.0.) The area under the empirical discounting function is equal to the sum of the areas of these trapezoids" (p. 240, Myerson et al., 2001).

## **1.5 Discounting Tasks and Adjustment Procedures**

In an attempt to obtain valid data on discounting behaviour, several procedures have been used. Bickel and Marsch (2001) reviewed the application of various techniques to discounting tasks in which indifference points are obtained across several delays. A number of these techniques are explored below.

### **1.5.1 Staircase procedure**

Simpson and Vuchinich (2000) used a hypothetical discounting task initially developed by Rachlin, Raineri, and Cross (1991), requiring participants to make choices between large hypothetical monetary rewards (fixed at \$1000) to be received after a delay and more immediately available hypothetical monetary rewards (that either increased or decreased in value throughout the session). A total of 30 immediately available reward amounts were presented to participants ranging from 0.1% to 100% of the large fixed amount. The students participated in two sessions one week apart with (I) immediate reward amounts ascending and (II) immediate reward amounts descending. For each session participants were presented with 30 choice trials at each delay (1 week, 1 month, 6 months, 1 year, 3 years, 5 years, 10 years and 25 years), equating to a total of 480 choice trials per session.

Table 1.1 *Ascending reward values presented in the staircase procedure (Simpson & Vuchinich, 2000).*

	\$1000 after 1 week	\$1000 after 1 month	\$1000 after 6 months	\$1000 after 1 year	\$1000 after 3 years	\$1000 after 5 years	\$1000 after 10 yrs	\$1000 after 25 yrs
<b>Now</b>	\$1	\$1	\$1	\$1	\$1	\$1	\$1	\$1
<b>Now</b>	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5
<b>Now</b>	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10
<b>Now</b>	\$20	\$20	\$20	\$20	\$20	\$20	\$20	\$20
<b>Now</b>	\$40	\$40	\$40	\$40	\$40	\$40	\$40	\$40
<b>Now</b>	\$60	\$60	\$60	\$60	\$60	\$60	\$60	\$60
<b>Now</b>	\$80	\$80	\$80	\$80	\$80	\$80	\$80	\$80
<b>Now</b>	\$100	\$100	\$100	\$100	\$100	\$100	\$100	\$100
<b>Now</b>	\$150	\$150	\$150	\$150	\$150	\$150	\$150	\$150
<b>Now</b>	\$200	\$200	\$200	\$200	\$200	\$200	\$200	\$200
<b>Now</b>	\$250	\$250	\$250	\$250	\$250	\$250	\$250	\$250
<b>Now</b>	\$300	\$300	\$300	\$300	\$300	\$300	\$300	\$300
<b>Now</b>	\$350	\$350	\$350	\$350	\$350	\$350	\$350	\$350
<b>Now</b>	\$400	\$400	\$400	\$400	\$400	\$400	\$400	\$400
<b>Now</b>	\$450	\$450	\$450	\$450	\$450	\$450	\$450	\$450
<b>Now</b>	\$500	\$500	\$500	\$500	\$500	\$500	\$500	\$500
<b>Now</b>	\$550	\$550	\$550	\$550	\$550	\$550	\$550	\$550
<b>Now</b>	\$600	\$600	\$600	\$600	\$600	\$600	\$600	\$600
<b>Now</b>	\$650	\$650	\$650	\$650	\$650	\$650	\$650	\$650
<b>Now</b>	\$700	\$700	\$700	\$700	\$700	\$700	\$700	\$700
<b>Now</b>	\$750	\$750	\$750	\$750	\$750	\$750	\$750	\$750
<b>Now</b>	\$800	\$800	\$800	\$800	\$800	\$800	\$800	\$800
<b>Now</b>	\$850	\$850	\$850	\$850	\$850	\$850	\$850	\$850
<b>Now</b>	\$900	\$900	\$900	\$900	\$900	\$900	\$900	\$900
<b>Now</b>	\$920	\$920	\$920	\$920	\$920	\$920	\$920	\$920
<b>Now</b>	\$940	\$940	\$940	\$940	\$940	\$940	\$940	\$940
<b>Now</b>	\$960	\$960	\$960	\$960	\$960	\$960	\$960	\$960
<b>Now</b>	\$980	\$980	\$980	\$980	\$980	\$980	\$980	\$980
<b>Now</b>	\$990	\$990	\$990	\$990	\$990	\$990	\$990	\$990
<b>Now</b>	\$1000	\$1000	\$1000	\$1000	\$1000	\$1000	\$1000	\$1000

Similarly to Du, Green and Myerson (2002), the IP for each delay was calculated as the average between the last immediate amount rejected during the ascending order session and the last immediate amount chosen in the descending order session. Simpson and Vuchinich reported that the choice task was reliable (as assessed by between-session correlations) and produced non-trivial indifference points across the selected range of delays. However, participants were required to complete a substantial total of 480 choice trials in each session, possibly inducing effects such as fatigue, and so limiting the validity of IPs obtained.

### **1.5.2 Mazur's adjustment procedure**

Additional studies have involved the use of adjusting procedures (similar to the procedure described above) to obtain indifference points, whereby a factor such as reward amount, delay, or degree of certainty, is adjusted depending on participants' choices. For example, Mazur (1987) developed an adjusting procedure in which pigeons chose between 2 seconds' access to grain after a fixed delay and 6 seconds' access to grain after a varied delay. This delay was increased (by 1 second) when the pigeon chose the 6 second reward, and decreased (by 1 second) when the 2 second reward was chosen. Therefore, choice options were altered according to a pigeon's previous choice and gradually converged on a point of indifference between the two reward options. Rodriguez and Logue (1988) conducted a series of studies using Mazur's adjustment procedure and found similarities between discounting in humans and pigeons and reported that a hyperbolic function best described the data.

### 1.5.3 Mitchell's standard-alternative procedure

Mitchell (1999) designed an alternative delay choice task involving a computerised adjustment method in which participants were presented with 137 choice questions on a computer screen. For each question, participants were required to indicate whether they preferred a “standard” or “alternative” reward. The standard reward consisted of \$10.00 available after one of six delays (0, 7, 30, 90, 180, and 365 days) and the alternative amount varied from \$0.01, \$0.25, \$0.50, and then by \$0.50 increments to \$10.50 and was given immediately. A single standard item and one alternative item were randomly selected for each choice question and were excluded from future selections to ensure no single question was repeated (see Table 1.2).

Table 1.2 *An example of a series of ten possible choice options presented to participants in Mitchell's (1999) delay task.*

<b>Choice number</b>	<b>Reward option</b>
1	\$10.00 after 0 days vs. \$3.00 now
2	\$10.00 after 90 days vs. \$5.00 now
3	\$10.00 after 7 days vs. \$0.50 now
4	\$10.00 after 30 days vs. \$8.00 now
5	\$10.00 after 7 days vs. \$8.50 now
6	\$10.00 after 180 days vs. \$1.00 now
7	\$10.00 after 180 days vs. \$7.00 now
8	\$10.00 after 365 days vs. \$4.50 now
9	\$10.00 after 90 days vs. \$8.50 now
10	\$10.00 after 0 days vs. \$0.50 now

Participants were given the opportunity to alter their choice if desired and at the end of the session one choice question was randomly selected. Participants chose the reward they wanted and an IOU was given if they chose the standard item stating the date they could collect their reward. Mobini, Grant, Kass and Yeomans (2007) found Mitchell's choice task to be positively correlated with a variety of self-report scales assessing impulsivity and concluded that Mitchell's choice task was a valid measure of delay discounting.

#### **1.5.4 Decreasing adjustment algorithm (DAA)**

In support of previous delay discounting research, Du, Green and Myerson (2002) found that as the delay to a larger reward was increased the number of responses to the delayed choice option decreased and reported similarities between American, Chinese and Japanese participants in delay and probability discounting (although the Chinese and American participants were reported to discount delays at slightly higher rates than the Japanese participants). Focusing specifically on the delay discounting method, Du et al. used a computer to display several choice options to participants involving two hypothetical amount conditions (\$200 and \$10,000 randomly selected) presented at seven delays in the following order: 1 month, 3 months, 9 months, 2 years, 5 years, 10 years and 20 years.

Du et al. gave participants 12 practice trials (containing only options they would not see in the main experiment) and then presented them with six different choices at each delay (a total of 84 experimental trials). The initial choice option in each delay was always the delayed amount (either \$200 or \$10,000) versus half the delayed amount to be given immediately (e.g., \$200 in 3 months versus



\$100 immediately). For the five subsequent choices the delayed amount remained fixed but the immediate reward amount was adjusted depending on the participant's previous choice (see Figure 1.8). The first adjustment (the second choice option) would be either plus or minus half the difference between the delayed amount and the more immediate amount. For instance, as illustrated in Figure 1.8, if the immediate reward (\$100) was chosen the next immediate choice would be reduced by half of the difference between the immediate and delayed reward (i.e., to \$50); if the delayed reward (\$200) was chosen the next immediate choice would be increased by half of the difference between the immediate and delayed reward (i.e., to \$150). All subsequent adjustments were either plus or minus half of the previous adjustment, thus the adjustment size (whether up or down) decreased within each of the six choice options.

Du et al.'s Decreasing adjustment algorithm (DAA) was designed to rapidly converge on an indifference point (calculated as the midpoint between the last immediate amount rejected and the last immediate amount chosen) at each delay in only six choice trials. This can be contrasted with Rodriguez and Logue (1988) in which 48 choice trials were presented in each session at each of five delays. For each delay the number of sessions varied between participants from three (a total of 144 choice trials) to 12 (a total of 576 choice trials). Similar titration techniques to that of Du et al. have been used and developed in other discounting research, including Sonuga-Barke, Lea and Webley (1989a,b,c); Richards, Zhang, Mitchell and De Wit (1999); Johnson, Bickel and Baker (2007); Estle, Green, Myerson and Holt (2007).

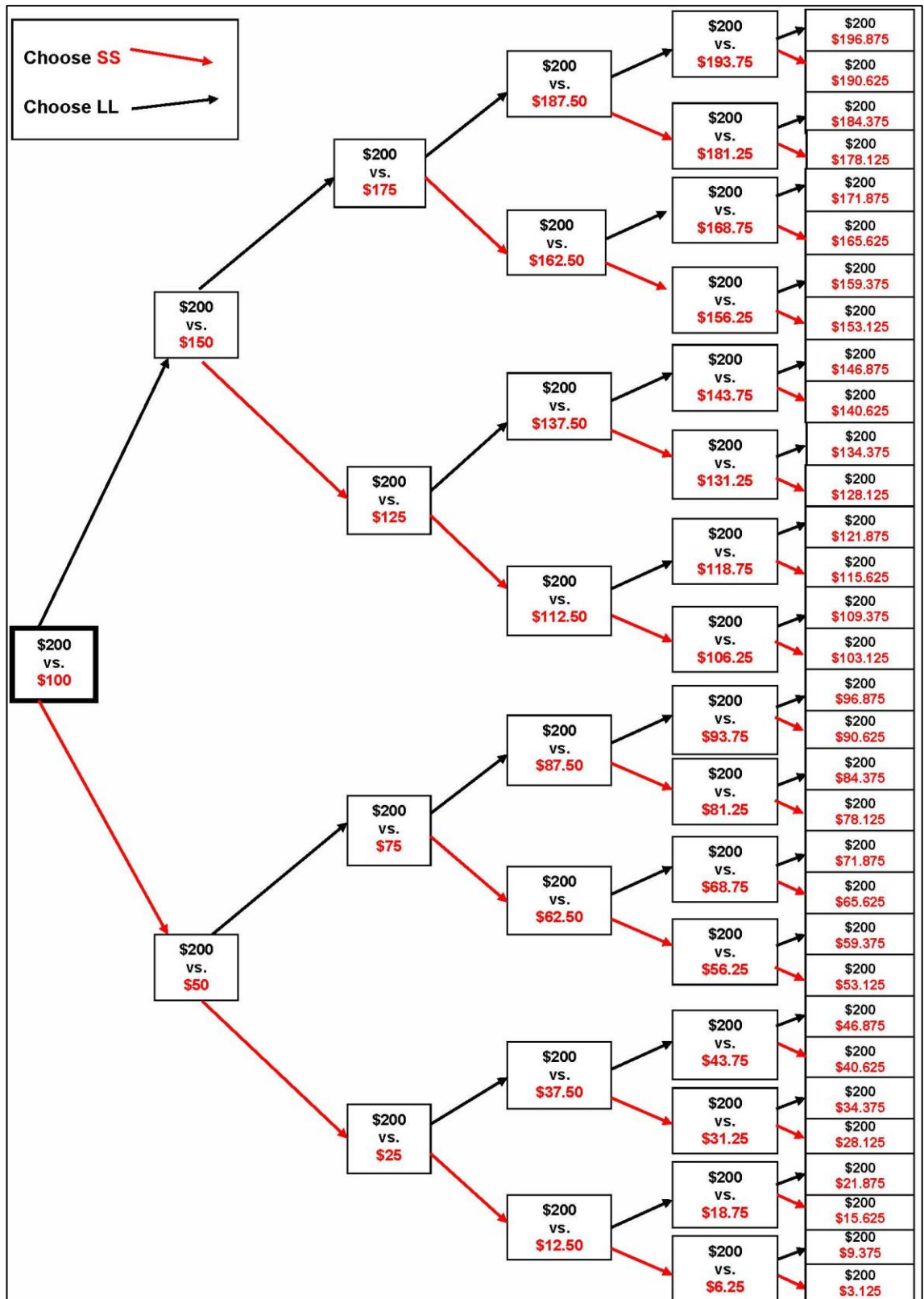


Figure 1.8 Pathways of adjusted immediate reward values in the \$200 delayed reward condition in Du, Green and Myerson (2002).

### **1.5.5 Double-Limit algorithm**

Johnson and Bickel (2002) and Olson, Hooper, Collins and Luciana (2007) studied impulsivity using a computerised delay discounting task, and associated adjustment procedure developed by Richards et al., 1999. Similar to the DAA developed by Du et al., the procedure involved a larger delayed reward that remained constant (\$10) and a smaller immediate reward that was adjusted depending on the participant's previous choice. Participants were presented with delay discounting questions such as "Would you rather have (a) \$6 now or (b) \$10 in 30 days?" (Richards et al., p. 126). The immediate small variable amounts were randomly selected from a range of values that gradually narrowed to converge on a participant's indifference point. These values included one minimum and one maximum top limit, and one minimum and one maximum bottom limit. The maximum top limit remained larger than the minimum top limit, and the maximum bottom limit remained smaller than the minimum bottom limit (for the initial choice trial the value was \$10 for the top limits and \$0 for the bottom limits).

The values were set to increments of \$0.50 and the first choice option included a small immediate reward randomly selected between the top and bottom limits of \$10 and \$0. However, succeeding trials involved fixed adjustments dependent on the participant's previous choice (as defined by specific rules, see Richards et al., 1999). For example, if an individual chose the delayed larger reward the upper and bottom limits increased for the next choice trial. Similarly, if the smaller, more immediate reward was chosen the limits decreased for the next choice trial. This caused the limits to narrow and consequently enabled indifference points (IPs) to be recorded at a point when consistent responding

was produced. Approximately 110 questions were asked in two experimental sessions, equating to approximately 11 questions per delay, depending when consistent responding occurred. To determine a total of ten IPs the median number of trials was 103 , the maximum was 148 trials and the minimum was 74 trials. Richards et al. reported good test-retest reliability of the discounting task and found correlations between the discounting task and paper-and-pencil personality measures (such as the Eysenck Personality Inventory (EPI), Eysenck & Eysenck, 1968).

#### **1.5.6 Review of discounting procedures.**

As can be observed from the present review, several different variations of discounting tasks have been produced, but it seems that relatively few comparisons have been carried out between delay discounting tasks. Kowal, Yi, Erisman and Bickel (2007) performed one such review comparing the DAA (Du et al.) and the Double-Limit algorithm (Richards et al.) described above. Participants were required to perform mouse clicks (similar to Solanto et al., 2001) to make choices between a large fixed delayed reward and smaller more immediate adjusting rewards. The two methods were counterbalanced and delays were presented in ascending order. Two reward amounts (\$10 and \$1000) at seven delays (1 day, 1 week, 1 month, 6 months, 1 year, 5 years and 25 years) were used. Both procedures produced evidence typical of delay discounting, significant strong correlations between both measures were identified and the hyperbolic function was reported to account for similar amounts of variance for the two methods. Kowal et al. (2007) reported that indifference points were generally slightly higher, and lower discounting rates were produced in the Double-Limit algorithm than for the DAA.

Kowal et al. suggested researchers be cautious when comparing data with other sources, but that conclusions drawn from different delay discounting methods are not likely to be vastly dissimilar. Kowal et al. noted that in studies in which time is important (e.g., individuals with limited attention capacity) the Double-limit algorithm would be less suited as participants are required to reach a point at which they respond consistently. However, Kowal et al. claimed that the DAA converges rapidly on subjective indifference points and, due to the option of correcting any undesired choices, still produces reliable points of indifference.

Richards et al. (1999) highlighted the validity and reliability of their adjustment procedure in measuring delay discounting, through correlation with other, well developed impulsiveness measures such as personality scales. Although Kowal et al. found typical discounting was similarly produced by both the DAA and the Double-Limit algorithm, the validity of the indifference points obtained from using the DAA could be questioned. Specifically, obtaining a single indifference point within six choice trials, it seems possible that participants are forced rapidly toward their point of indifference, whereby initial choices made are crucial to the indifference point. On the other hand, many adjustments involve a high number of choices and require consistent responding to obtain points of indifference (e.g., 480 choice trials per session in Simpson & Vuchinich, 2000). It is important to consider the influences of such factors in the measurement of impulsivity, for example, the effects of attention and boredom in studies of choice.

The decision on which discounting procedure a researcher should use requires evaluation of the appropriateness of the method to the specifics of their research. For example, the DAA might be preferred over the Double-Limit algorithm method when time is restricted. In addition to substantial differences regarding the number of choice trials involved in discounting tasks, studies of discounting have varied greatly on other factors, some of which are mentioned below. However, as stated by Critchfield and Kollins (2001), outcomes of delay discounting research remain similar, and consequently a novel discounting procedure could be regarded as valid if the indifference curves produced correspond to existing models.

### **1.6 Features of Discounting Tasks**

A number of features of discounting tasks have been varied to explore the various components involved in choice. Reward dimensions are commonly varied within and between studies of choice, and have included reward type, reward size, delay size, order of presentation of delay and the use of hypothetical versus real rewards. For example, Neef, Mace, Shea and Shade (1992), Neef, Mace and Shade (1993), and Neef, Shade and Miller (1994) used concurrent variable interval (VI) schedules to study how reward rate, quality, effort (task difficulty), and delay versus immediate rewards affected individual choices. Neef et al. (1992) reported that the time participants allocated to responding to rewards was proportional to the reinforcement obtained (as predicted by the matching law: see Herrnstein's collection of papers, Rachlin & Laibson Eds., 1997) when the quality of the reinforcers was the same throughout the response options, but not when the quality differed. Neef et al. (1993) established that although participants' choices were primarily based on

immediacy, reward value varied significantly between participants. A similar study by Neef et al. (1994) highlighted the importance of considering differences between participants regarding the degree to which they valued reward properties.

Due to practical constraints of using money as rewards in studies of discounting, research has recurrently involved the use of hypothetical amounts. Hypothetical rewards and delays defined by Rachlin, Raineri and Cross (1991) have frequently been used in research on delay discounting (e.g., Madden, Bickel & Jacobs, 1999; Simpson & Vuchinich, 2000). For example, Rachlin et al. (1991) presented pairs of reward cards consisting of hypothetical rewards to be delivered immediately or definitely (included: \$1000, \$990, \$980, \$940, \$920, \$900 to \$100 in increments of \$50, then \$80, \$60, \$40, \$20, \$10, \$5, \$1) and a reward of \$1000 to be delivered after a hypothetical delay (1 month, 6 months, 1 year, 5 years, 10 years, 25 years and 50 years).

As noted by Johnson and Bickel (2002), there are difficulties in giving participants real money when large monetary amounts are assigned to long delays (e.g., 25 years). Johnson and Bickel (2002) and Johnson, Bickel and Baker (2007) consequently conducted studies regarding the validity of hypothetical rewards for use in discounting research. Johnson et al. (2007) used a computerised delay discounting task with an adaptation of the Double-limit algorithm to measure discounting in smokers and non-smokers. Similar to Johnson and Bickel (2002), Johnson et al. (2007) used hypothetical rewards (of \$10, \$100, and \$1000) with hypothetical delays (ranging from 1 day to 25 years) and "potentially real" rewards (of \$10 and \$100) at real delays (ranging from 1

day to 6 months). Potentially real choices were generated by inviting participants at the end of the session to pick one choice trial from a bag; they would be given the reward they had chosen in that particular trial. Johnson et al. (2007) found rate of smoking in heavy smokers correlated with discounting rates. Both Johnson and Bickel (2002) and Johnson et al. (2007) found similar discounting rates were produced by hypothetical and real money rewards, and suggested therefore that hypothetical rewards could be used as valid substitutes for real monetary rewards in studies of delay discounting.

However, in a study providing evidence of discounting past outcomes, Yi, Gatchalian and Bickel (2006) suggested that a weakness of their research was the use of hypothetical rewards, and that in the presence of real rewards participants might have exhibited different behaviour. It could be suggested that research involving monetary amounts should consider the population sample being tested. For example, it seems reasonable to consider the degree of understanding young children may have of large hypothetical rewards, delays and monetary amounts. In such cases it may be more beneficial to use small, real rewards to generate choice options (e.g., using cookies or pretzels, Mischel & Ebbesen, 1970) to obtain reliable and valid results.

For example, Sonuga-Barke, Lea and Webley (1989a) presented a series of choice options to girls between 4 and 12 years of age, using rewards as tokens that participants could exchange later for sweets or toys. Choice options included a reward of two tokens after a long delay (20, 30, 40 or 50 seconds) versus a one token reward available after a short delay of 10 seconds. Sonuga-



Barke et al. reported results indicated a two-stage developmental process of self-control (see section 1.8 for more details).

Critchfield and Kollins (2001) reviewed similarities and variations in discounting research such as procedures and findings from animal and human studies with the view to emphasising the need for research into socially important behaviour, such as ADHD. One such consideration concerned variations in the amount of delay presented. As mentioned previously, Rachlin et al. (1991) used delays ranging from 1 week to 25 years, however, Coffey, Gudleski, Saladin and Brady (2003) presented 16 hypothetical delay conditions ranging from 5 minutes to 25 years in research on drug users. Coffey et al. initially piloted the use of delays used by Madden, Petry, Badger and Bickel (1997) but found the cocaine-dependent participants to be intolerant of the initial 1 week delay and therefore presented delays of 5, 15 and 30 minutes, 1, 6, and 12 hours, 1, 2, and 5 days, 1 and 2 weeks, 2 and 6 months, 1, 5 and 25 years. Coffey et al. used 27 hypothetical reward amounts (similar to those used by Rachlin et al., 1991) ranging from \$1000 to \$1.

Estle, Green, Myerson and Holt (2007) used an adjustment procedure similar to Du et al.'s DAA in which university student participants were required to make six choices at five delays. Unlike Du et al., Estle et al. used several coupled hypothetical amount conditions involving both monetary and consumable rewards, including: \$40 and \$100; 40 and 100 bars of candy; and 40 and 100 cans of beer/soda. Estle et al. randomly presented the different reinforcer types to overcome order effects and reported that "when rewards were delayed, monetary rewards were discounted less steeply than directly consumable

rewards" (p. 58). Money and candy were similarly used as rewards by Kirby et al. (2002). They suggested that different reward types are discounted at different rates and reported that rates of delay discounting were associated with factors including education, age and situational factors, such as current monetary income and hunger. Nonetheless, as evident from the large number of studies that have used money to explore delay discounting, money appears effective as a generalised conditioned reinforcer as it "retains its utility" (p. 62) and is exchangeable for primary and secondary reinforcers that individuals need or desire (Estle et al., 2007). For example, money could have been paired with a stimulus (such as food, drink, clothes, computer games or activities) that function as a reinforcer.

In addition to the use of different delays, reward amounts, reward types and adjusting procedures to measure discounting, a wide variety of tasks have been used, such as opening red and green boxes with keys (Brown & Rachlin, 1999), choice cards (Rachlin, Raineri & Cross, 1991), pressing response blocks to obtain tokens (Sonuga-Barke et al., 1989a) and arithmetic problems (Neef, Bicard & Endo, 2001; Neef et al., 2005). Solanto et al. (2001) conducted a "Choice-Delay Task" in which a computer programme presented choices between two squares worth different reward amounts on a screen. Participants (ADHD and controls) were required to move the computer mouse to the square they wanted to choose and click the mouse button. However, Hoerger and Mace (2006) argue that such behaviour is simply an arbitrary response and thus Solanto et al.'s results had limited ecological validity.

It is important to highlight that Hoerger and Mace (2006) subsequently noted a lack of comparisons between self-controlled and impulsive behaviour identified in laboratory research, and behaviour in natural environments such as school and home. Despite concerns regarding its validity, Hoerger and Mace maintained the only study to have explored relations between impulsivity in laboratory settings and natural settings was that of Solanto et al. (2001) who assessed impulsive responding by presentation of the choice-task described above, and also conducted behavioural observations in the classroom. Consequently, Hoerger and Mace conducted similar comparisons to test consistency between and reliability of the measures, whilst producing a more relevant test of delay discounting and an examination of sensitivity to task difficulty. Similar to Neef, Bicard and Endo (2001), Hoerger and Mace (2006) presented ADHD and control children with arithmetic problems on a computer screen to determine the effect of delay and task difficulty on discounting. Hoerger and Mace emphasised the importance of using "clinically relevant behavior" (p. 148), such as arithmetic questions rather than mouse clicks (Solanto et al., 2001), to provide more meaningful insight into delay discounting in children with ADHD.

Hoerger and Mace (2006) tested mathematical ability, rates of accuracy and preferred rewards prior to the testing sessions of which two sessions (one delay, one task difficulty) were carried out each week for 2 weeks and each session involved 14 choice trials (4 no-choice and 10 choice trials). In the delay task, choice trials involved the presentation of a maths problem on the screen and children were asked whether they wanted to complete the problem and get 1 reward immediately or complete the same problem and get 3 rewards after

one of two possible delays. In the task difficulty condition, children were asked whether they wanted to complete an easy maths problem and get 1 reward immediately or complete a difficult maths problem and get 3 rewards. To determine the degree of discounting, the mean number of choices participants made to the larger reward were calculated. Additionally, children were rated by their parents and observed for approximately 250 minutes each to assess their impulsive behaviour in the classroom and at home. Results suggested correlations between measures, with more impulsive choices made by children who were reported to display more impulsive behaviour at home and who behaved more impulsively in the classroom compared to their peers.

The present review has revealed a substantial body of research that suggests impulsive choice is a robust phenomenon: one that appears to be effectively measured by discounting tasks. A range of testing methods have been used, and the evidence suggests that the type of discounting task should be selected in the light of appropriateness to the target population. However, as emphasised by Hoerger and Mace (2006), it seems limited research has been carried out on the validity of discounting tasks through exploring relationships between rates of discounting and natural choice situations, such as at home and in school. Furthermore, although several studies have explored relations between discounting and personality scales (reviewed below), it seems more research is necessary to validate discounting behaviour through considering relations with other impulsivity measures, such as self-reports.

## **1.7 Self-report Measures of Impulsivity**

Moeller, Barratt, Dougherty, Schmitz and Swann (2001) argue that even though delay discounting tasks are suitable for repeated use, they "do not incorporate the social aspects of impulsivity and do not measure long-term patterns of behaviour" (p. 1784). On the other hand, Moeller et al. (2001) and Ettl et al. (2007) maintain that although self-reports are less suitable for repeated use and present a subjective measure of impulsivity, they do enable data to be collected over long periods of time and across a variety of situations. Several self-report measures of impulsivity and self-control have been developed and applied in psychological research, and some of them are detailed below.

Research has been carried out on developing personality scales that involve the measurement of impulsiveness in children and adolescents. Eysenck, Easting, and Pearson (1984) provided a brief summary regarding the development of their personality scales. In short, Eysenck and Eysenck (1963) claimed that impulsiveness contributed to Extraversion. Eysenck and Eysenck (1977) suggested impulsiveness was comprised of four main factors: impulsivity, risk-taking, non-planning, and liveliness, from which Zuckerman's Sensation Seeking Scale was formed (Eysenck & Zuckerman, 1978).

Eysenck and Eysenck (1978) later claimed that impulsiveness involved two main factors: Impulsiveness (acting and speaking without thinking) and Venturesomeness (sensation seeking and risk-taking). Eysenck and Eysenck (1980) used these factors in the development of the Impulsiveness, Venturesomeness, and Empathy scale for children, known as the Junior I.5. This produced satisfactory reliabilities, but in improving the reliabilities of the

scale Eysenck (1981) developed the Junior I.6. Eysenck, Easting, and Pearson (1984) verified the scoring key for a British version of the Junior I.6: a 77-item scale containing three sub-scales of Impulsivity, Venturesomeness and Empathy (23 yes/no items in each, a few of which overlapped). Sufficient reliability was reported for the Junior I.6, specifically .74 for boys and .78 for girls for the impulsiveness sub-scale, and it has been administered to a variety of populations, including Canadian children with ADHD (Shea & Fisher, 1996).

Further self-report measures of impulsivity and self-control have included the Dickman Impulsiveness Scale (Dickman, 1990), the UPPS (Urgency, Premeditation, Perseverance and Sensation seeking: Whiteside & Lynam, 2001), the BIS/BAS (Behavioural Inhibition System/Behavioural Approach System: Carver & White, 1994), the Self-Control Scale (Tangney, Baumeister & Boone, 2004) and the Barratt Impulsiveness Scale (BIS-11: Patton, Stanford & Barratt, 1995).

The BIS/BAS measures personality traits stipulated by Gray (1987) in a neuropsychological model of personality and motivation, whereby anxiety was based on a Behavioural Inhibition System (BIS) and impulsivity was based on a Behavioural Approach System (BAS). Whiteside and Lynam devised the UPPS in an attempt at bringing together facets of many different measures of impulsivity. The Self-Control Scale (Tangney et al., 2004) comprised 36 items including three domains of Task performance, Impulse control and Psychological adjustment. Tangney et al. additionally developed a shorter version known as the Brief Self-Control Scale (BSCS) and reported the scales

to have high internal consistency (.89 for the SCS and .84 for the BSCS respectively).

The Barratt Impulsiveness Scale (BIS-11) developed by Patton, Stanford and Barratt (1995) is a 30-item self-report measure regarding various behaviours based on a 3-factor model of impulsivity, specifically: Motor Impulsiveness, Non-planning Impulsiveness and Attentional Impulsiveness. The BIS-11 has been frequently used in parallel with discounting measures to determine degrees to which individuals are impulsive. For example, Mobini, Grant, Kass and Yeomans (2007) found high correlations between participants' scores on the BIS-11 and Mitchell's (1999) discounting task.

It has been reported that the BIS-11 is highly reliable and valid (Patton et al., 1995), is highly generalisable, and has correlated with other measures of impulsivity (Mobini et al., 2007; Miller, Joseph & Tudway, 2004). However, according to Moeller et al. (2001) it is unsuitable for repeated use. The BIS-11 has been used to assess impulsivity in a variety of populations, including Obsessive Compulsive Disorder (OCD) (Ettelt et al., 2007), and in relation to behaviours such as drug use, drink driving, seatbelt wearing and aggression in college students (Stanford, Greve, Boudreaux, Mathias & Brumbelow, 1996). No adolescent or junior English version has been devised thus far, however Fossati, Barratt, Acquarini, and Di Ceglie (2002) developed an Italian adolescent version by asking participants to indicate which items they found hard to understand and altering them to ensure understanding. Fossati et al. reported high internal consistency and correlations between other measures of impulsivity in ADHD and smoking populations.

## **1.8 Research Involving Discounting Tasks and Self-report Impulsivity Measures**

A limited number of studies have utilised both experimental and self-report assessments in an attempt to test and achieve consistency between measures. Madden, Petry, Badger and Bickel (1997) found delay discounting rates (using established time delays of 1 week, 2 weeks, 2 months, 6 months, 1 year, 5 years and 25 years) to be moderately correlated ( $r = .39$  for control participants, and  $r = .40$  for opioid-dependent participants) with scores obtained by participants on the I.7 Questionnaire and the BIS-11. Mobini, Grant, Kass and Yeomans (2007) found positive correlations between Mitchell's choice task and a variety of self-report scales measuring functional and dysfunctional impulsivity (identified by the Dickman Impulsivity questionnaire). Similarly, Mitchell (1999) reported high correlations between self-report measures of impulsivity (including the BIS-11 and Eysenck's I.7 Impulsiveness questionnaire) and a discounting task administered to smokers and non-smokers.

In a longitudinal study by Duckworth and Seligman (2005), "self-discipline" (or self-control, as otherwise known) in adolescents was measured through self-reports and delay discounting tasks. The self-report measures included the Junior I.6 Impulsiveness subscale (Eysenck et al., 1984), the Brief Self-Control Scale (Tangney et al., 2004) and the Kirby Delay-Discounting Rate Monetary Choice Questionnaire (Kirby, Petry & Bickel, 1999). The discounting measure was a Delay Choice Task that involved the presentation of a \$1 bill in an envelope. The students were asked if they would take it now or give it back in order to swap it for a \$2 bill a week later (this was conducted again after 7



months to determine test-retest reliability). Duckworth and Seligman reported good internal and test-retest reliability of the choice task. They found that individuals with low academic performance presented low self-discipline, and that discounting was correlated with self-report scores.

Research presented so far indicates consistency and moderate correlations between discounting tasks and self-report measures of impulsivity. However, some research has found no evidence of a relationship between these two types of measure. For example, Coffey, Gudleski, Saladin and Brady (2003) administered self-report measures including the BIS-11 and the Eysenck Impulsiveness Questionnaire (the I.7, the British adult version of the Junior I.6: Eysenck, Easting, Pearson & Allsopp, 1985) in addition to a delay discounting task. According to Coffey et al., no significant correlations were found between the self-report measures and the discounting task (a finding similarly reported by Vuchinich & Simpson, 1998). They suggested a number of possible explanations for this, including small sample sizes, differences between measures in the number of situations they assessed (e.g., several situations assessed by self-reports versus the single situation assessed by the discounting measure). Additionally, they questioned whether the correlation would have been significant if scores were taken from the impulsivity subscales rather than total self-report I.7 and BIS-11 scores.

In further support of this, Reynolds, Ortengren, Richards and De Wit (2006) carried out four different behavioural measures and three different self-report measures of impulsivity, including the BIS-11, the I.7 questionnaire, and the Double-Limit algorithm developed by Richards et al. (1999). They reported that

the self-report measures correlated with each other, but did not correlate with discounting measures, and therefore proposed that the self-report and discounting tasks measured different aspects of impulsivity.

Reynolds et al. emphasised that future research into various components of impulsivity (including physiological aspects) could provide increased knowledge of specific populations that commonly present impulsive behaviour, such as substance abuse and developmental disorders like ADHD. The variations in findings suggest that care should be taken when arriving at conclusions drawn from different types of measures. Accordingly, Bickel and Marsch (2001) suggested future researchers administer several different measures of impulsivity to increase understanding of relations between such measures.

### **1.9 Impulsive Behaviour in Specific Populations**

In addition to research on impulsive choice in samples from the general population and in animals, specific populations have been studied. Impulsivity is identified as a component of many clinical diagnoses (such as ADHD) and undesirable behaviours such as substance abuse and gambling. Critchfield and Kollins (2001) noted the necessity for research on discounting in individuals who present impulsive responding in order to increase understanding of "socially important behaviors" (p. 101). For example, research has been conducted on behaviours such as drug addiction (Bickel & Marsch, 2001; Coffey, Gudleski, Saladin & Brady, 2003), smoking (Johnson, Bickel & Baker, 2007; Reynolds, Karraker, Horn & Richards, 2003), alcoholism, gambling (Vitaro, Arseneault & Tremblay, 1997), and on individuals with psychiatric

disorders (Crean, De Wit & Richards, 2000), such as schizophrenia, and pathologies such as OCD (Obsessive Compulsive Disorder).

Estle et al. (2007) reported that consumable rewards (such as sweets) had similar properties to abused substances (e.g., beer). Estle et al. indicated that further research regarding discounting in substance abusers and the characteristics of such consumable rewards was important for future intervention strategies. For example, research conducted by Yi, Gatchalian and Bickel (2006) claimed that examining discounting of past outcomes in substance abusers could provide useful insight regarding intervention.

In a review, Bickel and Marsch (2001) compared research on impulsivity in substance abuse, including smoking and alcohol. They reported that findings from Vuchinich and Simpson (1998) indicated that higher rates of discounting were produced by participants who drank heavily than participants who drank occasionally. Additionally they presented evidence to suggest that individuals who were drug dependent presented highly impulsive responding on delay discounting measures. They maintained that to enable increased understanding of characteristics of rewards and impulsiveness, future research should use delay discounting measures to assess impulsiveness in a variety of populations.

Richards et al. (1999) used the Double-Limit algorithm to determine the effect of small amounts of alcohol on discounting and presented participants with a number of self-report scales (including the Eysenck Personality Inventory: Eysenck & Eysenck, 1968) and the Impulsiveness-Venturesomeness-Empathy questionnaire (IVE: Eysenck & Eysenck, 1978). Although they reported that the

self-report scales and behavioural discounting measure correlated slightly, discounting was not affected by alcohol intake. They reported that similar results had been gained previously, but claimed that the amount of alcohol given to the participants in their study may not have been sufficient to generate an effect. This illustrates the difficulties in studying impulsiveness in substance abuse due to ethical and practical constraints.

Nonetheless, increasingly research has been conducted on discounting in drug abusers in an attempt to further knowledge about characteristics of such behaviour and subsequently improve intervention strategies. Kirby, Petry and Bickel (1999) compared scores on a monetary choice questionnaire (developed by Kirby & Maraković, 1996) with discounting rates and self-report measures of impulsivity (the BIS-11 and Eysenck's I.5 questionnaire). The self-report scales and discounting measure correlated positively and discounting by heroin addicts was found to be higher than discounting by non-drug taking controls. Kirby et al. emphasised the immediacy of the rewarding "pleasant feelings, euphoria, and relief from withdrawal or dysphoria" (p. 78) in drug use, compared to the delayed negative experiences, such as withdrawal, that occur in making a more self-controlled choice of not taking drugs. Similarly, Madden, Bickel and Jacobs (1999) studied delay discounting (using cards with amounts and delays from Rachlin et al., 1991) in heroin-dependent participants. In support of previous research (e.g., Madden et al., 1997), they found that heroin-dependent individuals discounted heroin rewards at higher rates than monetary rewards, thus emphasising the high immediate value of heroin perceived by heroin-dependent individuals.

Coffey, Gudleski, Saladin and Brady (2003) reported that cocaine-dependent participants presented higher impulsiveness scores in the self-report scales (the I.7 Impulsiveness Questionnaire and the BIS-11) and higher discounting rates of hypothetical monetary rewards than matched controls. Furthermore, monetary rewards were discounted at slower rates than hypothetical cocaine rewards by cocaine-dependent participants, further emphasising the value of obtaining immediate cocaine in cocaine-dependent individuals. They reported that the delays used had been successfully discounted in previous drug research, though Coffey et al. found the cocaine-dependent participants were intolerant of the 1 week delay: participants preferred the "\$1 of crack/cocaine immediately rather than wait 1 week for \$1000 worth of crack/cocaine" (p. 22). Similar to Madden et al. (1999), Coffey et al. suggested that the intolerance could indicate the high immediate reward value of crack/cocaine compared to other drugs, and that further comparison research was needed to increase knowledge in this area.

Impulsivity has also been studied in relation to smoking behaviour. Mitchell (1999) found smokers responded more impulsively on discounting choice tasks, had higher impulsive scores on personality scales and shorter response times than non-smokers. Higher levels of risk-taking and impulsivity were found in scores from personality scales for male adolescent smokers than non-smokers (Williams, 1973). Additionally, Barman, Pulkkinen, Kaprio and Rose (2004) found evidence of an increased likelihood of cigarette experimentation in individuals who reported high impulsivity.

In a further study of impulsivity in smokers, Epstein, Richards, Saad, Paluch, Roemmich and Lerman (2003) administered two delay discounting measures, including Kirby, Petry and Bickel's (1999) monetary-choice questionnaire and the Double-Limit algorithm. Epstein et al. reported that both measures strongly reflected higher impulsive choice in smokers than non-smokers. The Double-Limit algorithm was also used by Johnson, Bickel and Baker (2007) with "never smokers", "light smokers" and "heavy smokers". They reported evidence in support of previous research suggesting higher discounting rates in smokers compared to individuals who have never smoked, and consequently highlighted the validity and reliability of such measures. More specifically, heavy and light smokers discounted money more than never smokers, and cigarettes more than money and health, demonstrating the high immediate value of cigarettes to smokers (similar to the high immediate value of drugs to drug-dependent individuals).

A study by Sturm, Furnell and Gillberg (2004) reported that of 101 children with Autism Spectrum Disorders (ASD) who participated in their research, 50 percent presented impulsiveness. Research has also been conducted on impulsiveness in individuals diagnosed with ADHD (e.g., Winstanley, Eagle & Robbins, 2006; Solanto et al., 2001). Neef and colleagues conducted a series of studies with individuals with special educational needs (Neef et al., 1992), emotional difficulties (Neef et al., 1993), learning and behavioural difficulties (Neef et al., 1994), and studies comparing children with ADHD (medicated and non-medicated) to typically developing controls (Neef, Bicard & Endo, 2001; Neef et al., 2005).

Moeller et al. (2001) reviewed research that suggested impulsive traits were commonly presented by individuals with ADHD and Conduct Disorder, Substance abuse, Borderline Personality Disorder, Bipolar Disorder, and Antisocial Personality Disorder. It was highlighted that *impulsivity* was an element included in the DSM-IV diagnostic criteria for some of these disorders. Crean, De Wit and Richards (2000) used Richards et al.'s (1999) Double-Limit algorithm to measure discounting in 24 patients with disorders such as those mentioned above. They characterised participants on the likelihood of their engaging in impulsive behaviour according to the DSM-IV criteria: 12 were described as “low risk” and 12 as “high risk”. Participants also received the IVE (I.7) questionnaire (Eysenck, Pearson, Easting & Allsopp, 1985). Crean et al. reported that the high risk patients discounted at a higher rate than the low risk patients, and scored higher on the self-report scale.

Neef et al. (2005) studied impulsive choice in children with ADHD (medicated and non-medicated) and non-ADHD controls. Both medicated ADHD children and non-medicated ADHD children were reported to be mostly influenced by reward immediacy, rather than quality of the reward or task effort, indicating no effect of medication on impulse control. The non-ADHD participants were most influenced by reward quality, and thus were reported to have presented more self-controlled responding. Additionally, this study highlighted individual differences in reward quality which could be used against immediacy of reinforcement to promote self-control (in support of research by Neef et al., 2001).

As described previously in this review, there is evidence to suggest that impulsivity is involved in undesirable behaviours such as addictions to cigarettes, drugs, or gambling. Impulsivity is also referred to in several clinical diagnoses, including ADHD and bipolar disorders. Research on impulsivity within specific populations could generate a better understanding of the difficulties such individuals encounter, and in turn assist in the development of strategies to decrease undesirable behaviour and increase desirable behaviour possibly through self-control training.

### **1.10 Self-control**

Research that has been carried out on impulsivity has also addressed self-control. As mentioned in section 1.3 of this review, self-control has been defined within the delay discounting literature as the choice of larger, more beneficial rewards that are received after a delay. In developing a self-report scale of self-control, Tangney, Baumeister and Boone (2004) referred to self-control as “the ability to override or change one’s inner responses, as well as to interrupt undesired behavioral tendencies and refrain from acting on them” (p. 275). They maintained that self-control was beneficial in life to produce positive consequences in situations such as school. Tangney et al. reported evidence to suggest that this was indeed the case, as high self-control was found in people who achieved better grades, had fewer problems with impulse-control (such as alcohol abuse), and presented higher self-acceptance than in individuals with low self-control.

Several theories of self-control have been proposed. Numerous studies by Baumeister (e.g., Baumeister, Vohs & Tice, 2007; Muraven & Baumeister,



2000; Muraven, Tice & Baumeister, 1998) have suggested that self-control has a limited capacity, and exerting self-control gradually depletes the strength of it in future events (much like energy gradually draining from a muscle as it is used more). On the other hand, Sonuga-Barke et al. (1989a) suggest a two stage development of self-control. In Stage 1, reward size was considered most important and children learned *how* to wait for a more advantageous but delayed reward; in Stage 2, reward rate was considered more influential and children learned *when* waiting for a reward is more beneficial. A second paper by Sonuga-Barke et al. (1989b) provided further evidence in support of this two-stage process. They offer possible explanations for impulsive behaviour including: miscalculation of reward rate, insufficient self-control capacity (e.g., a child's limited conception of time), and the effect of social contingencies. Similar developmental progression in delay discounting was reported by Olson, Hooper, Collins and Luciana (2007), where younger adolescents showed faster discounting of delayed rewards.

More frequently, self-control has been studied with regard to the development of techniques to decrease impulsive behaviour and increase self-control. As highlighted by Green and Myerson (2004), implications of discounting research, particularly regarding specific behaviour problems such as substance abuse, could provide useful insight into predicting potential behavioural problems. They suggested the application of discounting measures to assess and predict individuals at risk of presenting behaviour problems and to identify individuals who would benefit from interventions to increase self-control. In an attempt to apply delay discounting to real-world contexts, a significant body of research has been conducted regarding self-control training.

According to Neef et al. (1994), future treatment to enhance self-control should consider individual differences, contexts and reward dimensions. Green and Snyderman (1980) reported that organisms choose smaller immediate rewards over larger rewards to be received after a delay, however when delay to both rewards is increased, organisms shift their preference towards the larger, more delayed reward, therefore demonstrating greater self-control. Consequently, it could be argued that under the right circumstances, organisms will demonstrate self-control and show a preference for larger, more beneficial but more delayed rewards over smaller immediate rewards.

A small number of studies have implemented self-control training procedures (e.g., Neef, Bicard & Endo, 2001; Dixon, Hayes, Binder, Manthey, Sigman & Zdanowski, 1998). Neef et al. (2001) reported that students with ADHD were primarily influenced by immediate reinforcement, as they made more impulsive choices than their controls. Following a short assessment identifying the two most influential reward dimensions for each participant, Neef et al. carried out a self-control training schedule. Participants were presented with their most influential dimension (for all participants this was immediacy of reward) versus their second most influential dimension (rate or quality of reward). As the rate or quality of the reward increased the delay to that reward was also increased. Baselines were taken and the self-control training procedure started with a delay of 15 minutes. The participant was required to allocate 70 percent of their time on two consecutive sessions to the delayed reward, then the delay was gradually increased in 15 minute increments. Neef et al. reported that participants made fewer choices of their initially preferred dimension

(immediacy), and made more choices towards the delayed high rate/high quality rewards (with delays of up to 24 hours), suggesting the training was successful at increasing self-controlled responding.

In a study of addictive behaviour, Monterosso and Ainslie (2007) proposed a 12-step strategy to increase self control in which individuals worked towards small realistic targets (e.g., take one day at a time) rather than unrealistic targets (e.g., 'I'll never drink again', p. 8), a process in which an individual is less discouraged by failures and more encouraged by successes. Kirby and Guastello (2001) and Monterosso and Ainslie (2007) emphasised the value of choice bundling, that is presenting people with series of rewards available across defined intervals. For example, "would you prefer: (a) to receive one slice of pizza today and weekly thereafter for 4 successive weeks, or (b) to receive two slices of pizza in 1 week and weekly thereafter for 4 successive weeks?" (Kirby & Guastello, 2001, p. 154). In absence of rewards offered in the four successive weeks, participants who like pizza would typically choose option (a). However, presented with the complete example above, option b is likely to be preferred by participants who like pizza, therefore improving self-control by "viewing a choice in anticipation of similar future choices" (Kirby & Guastello, 2001, p. 154), a proposal previously suggested by Ainslie (1975).

Dixon et al. (1998) carried out a study to increase appropriate behaviour in adults with developmental disabilities through self-control training. They carried out naturalistic baseline observations (involving a staff member to prompt, observe and record the duration of each participant's target behaviour over 20 sessions), followed by a choice baseline (5 to 7 sessions) in which participants

were asked “Do you want X (small reinforcer) now (with no target behaviour required), or do you want Y (large reinforcer) after doing Z (the target behaviour for the desired duration)?” (p. 206). Self-control training commenced when participants consistently chose to work for the large reward. In the self-control training, “a gradual progressive-duration contingency” was added to the larger reward (e.g., “Do you want X now, or do you want Y after doing Z for a little while?”, p. 206). The duration contingency was gradually increased when the target behaviour had been completed for the desired amount of time over two to three sessions. When participants chose the smaller immediate reward the duration contingency was halved. Dixon et al. reported that this procedure increased target behaviours and self-control.

A similar study was conducted by Binder, Dixon and Ghezzi (2000), in which a similar training procedure was used with children with ADHD. Procedures were generally similar, but the children were additionally required to perform two verbal tasks. Results supported findings from Dixon et al. (1998) and suggested that the self-control training was successful for young children with ADHD. Dixon and Cummings (2001) used a similar procedure to decrease self-injurious and aggressive behaviour and increase self-control in children with autistic spectrum disorders. They reported that self-control increased in sessions involving the progressive-delay procedure and self-injurious and aggressive behaviour decreased in sessions involving the self-control training and an activity.

Dixon, Rehfeldt and Randich (2003) also studied the effectiveness of a similar progressive-duration self-control training procedure on three mentally ill

participants. They found further evidence that the procedure increased self-control by gradually increasing delays to large rewards and the concurrent presentation of intervening activities. Dixon et al. (2003) emphasised the importance of self-control to develop “life-enhancing skills for clients who often encounter reinforcers that are not available immediately” (p. 266).

Interventions presented in this section indicate that increasing desirable behaviour through self-control training has been successful in its application to small participant samples. It seems reasonable to emphasise the importance of further research regarding self-control training and interventions to increase more desirable behaviour, and to assess their generalisability in applied contexts such as school. The value is potentially high for populations who frequently present undesirable behaviour due to impulsivity. The majority of the self-control training presented above has involved behaviour modification through altering reward dimensions. The following sections discuss other interventions that have been developed, including those focussing on the involvement of cognitions in impulsiveness.

### **1.11 Self-awareness**

Decision-making research in the Cognitive tradition has presented a variety of explanations regarding impulsive and self-controlled choice behaviour. Sanfey, Loewenstein, McClure and Cohen (2006) reviewed evidence to suggest the presence of a multiple system in delay discounting tasks, whereby impulsive and self-controlled choices activated different brain regions. Areas activated during impulsive choices (referred to as the Beta system) related to automatic reward evaluation but were not associated with future planning. Areas activated

during self-controlled choices (referred to as the Delta system), involved more effective assessment of future rewards through the activity of components involved in cognitive processes. Such evidence implies increased cognitive processes are involved in self-controlled choice and impulsive responding occurs automatically in absence of future regard.

Economic theorists have directed much research towards decision-making regarding financial and consumer activities. Thaler (1999) conducted and reviewed research on cognitions involved within such decision-making. Included within this was research on self-control as it has been argued that saving and investing behaviours involve self-controlled decision-making. For example, rather than spending any available money buying an immediate reward, how do individuals make the controlled decision to save it and get a large reward of increased interest later? Thaler claimed that "Mental accounting matters", that is "the set of cognitive operations used by individuals and households to organise, evaluate, and keep track of financial activities" (p. 183). This review generally implied that choice is influenced by mental accounting and hence that increased 'thinking' was valuable in promoting self-controlled choice.

Thus it appears possible that an individual responding to a larger delayed reward may require more time to think than when responding to a smaller more immediate amount in a choice task. Shorter response times are therefore likely to be associated with more impulsive choices. This is supported by McCown, Johnson and Shure (1993), who found that high impulsivity was associated with shorter response times.

Behavioural discounting research by Robles and Vargas (2007) also recorded participants' response times to delayed and more immediate rewards. They maintained that response time corresponded to the effort of choosing between two different reward options. The closer individuals get to their point of indifference, the more they ponder and consider the options, and consequently they present larger response times during these choices. Similarly, Mitchell (1999) recorded participants' response times in addition to indifference points and scores from self-report measures. Response times were recorded from the initial presentation of a question to the point at which participants indicated that they were certain about their choice. This study found that smokers presented more impulsive responding and shorter response times than the non-smokers, subsequently providing evidence to suggest that impulsive responding might involve less time thinking about the choice options.

According to Mobini et al. (2007), two types of impulsivity exist: functional impulsivity (involving quick more beneficial choices) and dysfunctional impulsivity (rapid, non-reflective choices involving "maladaptive cognitive attributes", p. 1526). This is similar to a cognitive theory by Beck (1976) in which forethought is considered limited in individuals with dysfunctional impulsiveness.

Research concerning the involvement of thoughts in decision-making of individuals who present highly impulsive behaviour (such as ADHD and substance abuse) may increase understanding of such often detrimental behaviour. Discounting research has shown that organisms frequently make impulsive choices, and that organisms have different indifference points depending on the parameters of the study. However, there is limited research

concerning the involvement of thoughts in impulsive behaviour of specific populations such as adolescents with behavioural, emotional and social difficulties (BESD). Such research has the potential to provide insight into intervention methods to increase self-regulation of socially appropriate behaviour and independence in such individuals.

As reported in section 1.2 of the current thesis, individuals with BESD include those with diagnoses of ASD and/or ADHD, both of which feature impulsivity as a major characteristic. Considerable research has identified strong evidence that individuals with ASD have difficulties in accounting for the mental states of others, a term commonly referred to as *theory of mind* (e.g., Perner, Frith, Leslie & Leekam, 1989; Baron-Cohen, Leslie & Frith, 1985). Moreover, a small volume of research has found that in addition to a deficient theory of mind, individuals with ASD similarly have difficulties attributing mental states to themselves (e.g., Frith & Happé, 1999). It seems reasonable to consider whether impulsivity might be affected by the degree to which individuals are aware of their own thoughts.

Frith and Happé (1999) proposed a model regarding theory of mind and self-consciousness in individuals with ASD, suggesting ASD to be a useful tool in investigating self-consciousness. They reported similarities between theory of mind (an ability to impute beliefs to others) and self-consciousness (an ability to attribute mental states to oneself). Frith and Happé (1999) and Kazak, Collis and Lewis (1997) found evidence to support the notion that individuals who lack an ability to access the mental states of others, also have limited ability in accessing their own mental states.



In a study by Perner et al. (1989), children with ASD were asked questions about the contents of a cup in terms of what they knew (knowledge attribution) and saw (visual access) and what an experimenter knew and saw. Knowledge about the contents of a cup varied as visual access differed: on some occasions only the child was invited to look, and on other occasions only the experimenter was allowed to look. Perner et al. found that most of the autistic children in their study correctly evaluated visual access, for both themselves and for the other experimenter. However, the "sample of autistic children were much less able to make correct knowledge attributions to themselves or to the other person" (p. 695), suggesting that individuals with autism have some difficulties with self-awareness and attributing the knowledge of others.

Perner et al. also reported evidence that offers support for a late acquisition of explicit theory of mind through learning in individuals with high functioning ASD and Asperger's Syndrome. If this is possible through learning then could the awareness of one's thoughts be a skill in which facilitation could occur? Perner, Lang and Kloo (2002) carried out research on theory of mind and self-control, within which Wimmer (1989) and Perner (1991) "suggested that children gain better self-control with a better understanding of their mind" (p. 763). Therefore, it appears possible that an increase in such awareness might improve an individual's self-control.

Previous research identified in this review produced evidence in support of behavioural self-control training procedures to reduce impulsive responding. If conscious thought is involved in choice, it may be possible to reduce impulsive

behaviour by increasing an individual's thinking in choice situations. Therapies such as Cognitive Behavioural Therapy have been employed in anger management programmes and have produced effective results (e.g., Beck & Fernandez, 1998).

Mobini, Pearce, Grant, Mills and Yeomans (2006) identified a possible component of impulsive behaviour as a limited ability to fully consider the consequences of behaviour. They studied the relationship between impulsivity, cognitive distortions and sensation seeking and found that those with higher impulsive behaviour had more cognitive distortions and higher sensation seeking scores. More specifically, they found that impulsiveness and cognitive distortions were positively correlated, and age and cognitive distortions were negatively correlated. Mobini et al. (2006) suggested that cognitive behavioural therapy should consider information processing to facilitate comprehension of different situations and improve self-control, and highlighted the importance of understanding such cognitive distortions in attempts to generate effective interventions.

### **1.12 Mindfulness**

In dealing with behaviour problems, several interventions have involved a focus on the modification of both behavioural and cognitive components. Behaviour modification involves the alteration of stimuli (such as objects and events) in “an individual’s current environment” (Martin & Pear, 2007, p. 6), in order to increase desirable behaviours. However, an alternative approach involved a cognitive focus and the two methods were combined to form a second wave of behaviour modification known as Cognitive Behavioural Therapy (CBT). This

therapy involves the modification of behaviour through replacing negative thoughts, feelings and beliefs with more productive ones (Hayes, 2004).

Hayes (2004) has identified a third wave of behaviour therapy including Acceptance and Commitment Therapy (ACT: Hayes, Strosahl & Wilson, 1999) and mindfulness-based interventions. ACT is based on an approach known as Relational Frame Theory (RFT: Hayes, Barnes-Holmes & Roche, 2001). "According to RFT, the core of human language and cognition is the ability to learn to relate events under arbitrary contextual control" (Hayes, 2004, p. 648). For example, the written word "dog", the spoken word "dog" and an actual dog are learnt through training. However, when scared by a dog barking loudly, the future appearance of a dog induces fear. This is transferred to related stimuli, producing a fear response when presented with the written word and spoken word "dog". Such relations result in relational frames that enable the consideration of events not present, positive and negative consequences, problem solving (Martin & Pear, 2007) and associated constructive and destructive thoughts.

According to Hayes (2004), in repeatedly trying to suppress negative thoughts or actions, these means of avoidance (e.g., suppression) become cues for events we are trying to avoid "because they strengthen the underlying relational frames" (p. 650). Because "myriad derived relations are available to maintain and reestablish a given relational network" (p. 650), unproductive relational frames (such as an initial panic attack in a shopping mall brought on by worrying about being trapped) are difficult to alter verbally, but are more easily altered through the process of acceptance.

Acceptance, unlike CBT, in this form literally denotes to accept what one observes in a situation as passing events, not to judge positively or negatively, and deal with observations constructively. Acceptance and Commitment Therapy (ACT) involves three components: Initially, the individual understands that previous unsuccessful efforts to control negative feelings and thoughts may have increased their occurrence. Secondly, the individual learns to accept aversive thoughts and feelings through mindfulness and acceptance training. Finally, the individual selects some real-life values (e.g., within their family), converts them into achievable goals, and then commits to achieve these goals.

Mindfulness-based behaviour therapies, such as ACT, have been used to treat a range of behavioural difficulties and psychological issues. For example, a component from ACT (personal values) was used by Heffner, Eifert, Parker, Hernandez and Sperry (2003) in the treatment of alcohol dependence in a male participant. The participant selected values from nine life domains (such as family, friends and career) and then set goals that reflected the values. Heffner et al. (2003) reported that the participant made increasingly positive comments regarding selected goals and values throughout his treatment. Heffner et al. reported the intervention to be a success as the participant achieved almost one hundred percent sobriety and reported a better quality of life. Heffner et al. emphasised the importance of further research to determine the potential effectiveness of mindfulness-based treatments on and between different populations.

The mindfulness component of ACT has also been applied independently. As reported by Broderick (2005), mindfulness “has been defined as intentional, nonjudgmental awareness of the present moment as opposed to a mode of thinking and feeling on 'automatic pilot'” (p. 502). According to Martin and Pear (2007) mindfulness entails the awareness and observation of behaviours as they occur. For example during an event, one is aware of sensations and feelings such as tastes, smells and touch. More specifically, Martin and Pear give the illustration of waiting for a friend who is always late: rather than being angry at them and experiencing negative, unconstructive thoughts about the situation, one could act mindfully by observing the situation objectively, taking account of cars that drive past, noticing one’s breathing and smells in the environment, and so on.

Mindfulness has been and continues to be used within the Buddhist tradition (Ramel, Goldin, Carmona & McQuaid, 2004) through the application of meditation techniques to improve personal affliction. Aptly described by Bishop et al. (2004), "Mindfulness in contemporary psychology has been adopted as an approach for increasing awareness and responding skillfully to mental processes that contribute to emotional distress and maladaptive behaviour" (p. 230). Mindfulness meditation and techniques have been employed in a number of clinical populations (Ramel et al., 2004). For example, mindfulness has been found to reduce rumination (Broderick, 2005; Ramel et al., 2004), depression (Ramel et al., 2004) and habitual responding (Wenk-Sormaz, 2005), to improve emotional regulation (Arch & Craske, 2006), and to assist the rehabilitation of adolescents with chronic pain (e.g., Wicksell, 2007; Wicksell, Melin & Olsson, 2007). Segal, Williams and Teasdale (2002) found that Mindfulness-Based

Cognitive Therapy (MBCT) was effective in treating depression and reduced the occurrence of future relapse developed to treat depression and emphasised the potential benefit of future research into interventions involving mindfulness.

Baer, Fischer and Huss (2005) implemented an MBCT intervention for binge eating. They reported that the participant lost no weight (potentially due to the participant's weight loss prior to the study), but highlighted that the participant became more satisfied with her eating behaviour, her weight and her shape following MBCT. The Kentucky Inventory of Mindfulness Skills (KIMS: Baer, Smith & Allen, 2004) indicated an increase in mindfulness for this participant, and consequently provided support for MBCT as beneficial for increasing positive thinking.

Several scales have been developed to measure Acceptance and Mindfulness, many of which are presented in an ACT Measures Package by Ciarrochi and Bilich (2006). Specific mindfulness self-report measures included the Mindful Attention Awareness Scale, MAAS (Brown & Ryan, 2003) and Child Acceptance and Mindfulness Measure (CAMM: Greco & Baer, 2005). The MAAS is a 15-item scale requiring individuals to rate their experience of each statement from 1 (almost always) to 6 (almost never). Brown and Ryan (2003) reported the MAAS to have good (.81) test-retest reliability, internal consistency and validity. The CAMM is a 25-item scale requiring participants to rate how true each statement is of them from 0 (*never true*) to 4 (*always true*) and is reported to have high internal consistency and validity (Ciarrochi & Bilich, 2006). Although both have been used in studies involving children and adolescents, the CAMM appears to offer a more general assessment of the degree to which

"children and adolescents observe internal experiences, act with awareness, and accept internal experiences without judging them" (p. 143, Ciarrochi & Bilich, 2006).

As previously indicated, impulsivity is characteristic in addictions such as substance abuse and gambling, and disorders such as ADHD and ASD. Bögels, Hoogstad, Van Dun, De Schutter and Restifo (2008) reported that after an 8 week mindfulness training programme adolescents with externalising disorders (such as ADHD and ASD) had improved attention, happiness and increased mindfulness. Both adolescents and their parents reported improvement on their personal goals and according to Bögels et al. (2008) these effects remained 8 weeks after training. In addition, Zylowska et al. (2008) and Smalley et al. (2009) reported beneficial effects of applying mindfulness training as part of an intervention for improving behaviour in individuals with ADHD.

In further support of a relation between impulsivity and mindfulness, evidence suggests that mindfulness affects responses to smoking urges (Bowen & Marlatt, 2009) and is a good predictor of gambling outcomes (Lakey, Campbell, Brown & Goodie, 2007). Muraven, Tice and Baumeister (1998) found that suppressing forbidden thoughts (the opposite intention of mindfulness) resulted in impaired self-control, including difficulties controlling emotional reactions and tendencies to give up challenging tasks more quickly. Further beneficial effects of mindfulness-based training to reducing aggressive behaviour were identified by Heppner et al. (2008) and Singh et al. (2006). Singh et al. found

mindfulness-based training reduced aggression, decreased the frequency of restraints and increased learning in participants with developmental disabilities.

A comprehensive review of literature relating mindfulness-based therapy to impulsive behaviour was presented by Stratton (2006), who highlighted that poor emotional regulation could be related to impulsive behaviour as either a consequence or influential factor. She gave the example of binge eating as a consequence of negative affect involved in eating disorders, such as bulimia nervosa. Hofmann and Asmundson (2008) pointed out that ACT is reported to have been more effective than CBT in treating individuals with emotional disorders. Therefore, it seems reasonable to investigate whether mindfulness-based training could provide an effective intervention for adolescents with BESD. More specifically, to determine whether there is a relationship between mindfulness and impulsivity in this population, and if so, whether training in mindfulness reduces impulsivity.

### **1.13 Research Aims**

As mentioned in section 1.2, given the intake of pupils with BESD at the collaborating school, their diagnoses covered a range of disorders and complexities. Despite possible difficulties with variability and control, as our agreement was specifically for research into developing a strategy to facilitate more effective self-regulation in pupils throughout the school, we were constrained to working with a mixed sample.

In response to the research described in chapter 1, several aims were proposed. Firstly, the present research required effective measurement of



impulsivity. Since the few techniques that had been designed for use with adolescents with BESD were unavailable (see section 2.1), it was necessary to design a delay discounting task with the aim of obtaining valid information on impulsive choice (see sections 1.3, 1.4, 1.5, 1.6 and 1.9) in adolescents with behavioural, emotional and social difficulties (BESD). Therefore, the first research question to address was whether the discounting task designed for use in the current research project was effective at measuring impulsive choice (i.e., produced discounting) in the mixed sample of adolescents with BESD. Secondly, this research aimed to determine whether the delay discounting task designed for the present research correlated with other measures of impulsivity (e.g., self-reports and classroom observations).

It seems reasonable to propose from the literature presented in sections 1.1 and 1.2, that in addition to difficulties with impulse control, adolescents with BESD, such as those with ASD, might have a limited capacity for realistic self-awareness, and that these two characteristics might be related. Although some research indicates a relation between impulsivity and mindful awareness (section 1.12), it is in its early stages and more research is necessary to establish this relation more fully. The third question addressed in the present research therefore, was to explore whether there was a relationship between the different measures of impulsivity and mindfulness in adolescents with BESD.

A small number of studies have measured the amount of time individuals take to respond when making impulsive and more self-controlled choices (section 1.11). Such studies have suggested that less "thinking" is involved in more

impulsive choices, in comparison to self-controlled choices that involve longer deliberation. In response to this, and with regard to the third research question into whether increased self-awareness is related to less impulsivity, the fourth research question addressed was whether responses were faster when making impulsive choices and slower when making more self-controlled choices.

Literature referred to in section 1.1 identified several different methods (including token economies and therapeutic interventions) that have been employed to deal with the challenging, often impulsive behaviour (see section 1.9) exhibited by individuals with BESD and related conditions. Such interventions are either difficult to implement, or are reported to have had limited success (section 1.1). As it has been suggested that self-awareness might be a skill that can be developed through training (Thompson, 2008; Frith & Happé, 1999), it seemed reasonable to examine whether self-awareness training (such as mindfulness training) could increase self-awareness and reduce impulsive behaviour, thereby resulting in more effective self-regulation. If evidence implied that highly mindful individuals were less impulsive, the final research question aimed to determine whether a short mindfulness-based training procedure would increase mindfulness and reduce impulsivity (as measured by various measures of impulsivity used throughout this research).

To summarise, the current project attempted to explore the relationship between impulsivity and mindful-awareness using a variety of measures suitable for use with adolescents with BESD. In the event that evidence suggested such a link existed, a mindfulness-based training intervention would be performed. Ultimately, finding an effective therapy to reduce impulsive

responding through improving self-awareness in adolescents with behavioural, emotional and social difficulties (BESD) could be beneficial to these individuals by facilitating more effective self-regulation.

## **Chapter 2: Experiments 1 and 2**

### **Designing the Discounting Task**

#### **2.1 General Introduction**

Previous research on impulsivity has focused on the study of choice through computerised delay discounting tasks, in which an organism is presented with a situation involving two options varying in delay and size (see chapter 1). Such delay discounting research has used several different kinds of tasks, different adjustment procedures to obtain indifference points (IPs), different methods of calculating IPs, and a variety of features such as reward type, reward size, delay size and order of presentation of delay. Given such a range of differences and combinations, it is not surprising that no consensus as to the best measure of delay discounting has been identified.

As mentioned in chapter 1, several delay discounting tasks have been designed, some of which have been used in research with children and adolescents. For example, Solanto et al. (2001) presented ADHD and control children with choice options involving two different coloured squares on a computer screen. However, Hoerger and Mace (2006) argued that such mouse clicking tasks lacked relevance to real (e.g., educational and financial) situations, and instead presented participants with educationally relevant arithmetic tasks (e.g., similar to Neef et al., 2005). Although computerised delay discounting tasks have been effectively developed for use with children with ADHD, Hoerger and Mace were unable to provide a copy of their task due to modifications being made to it. Consequently, the development of a novel computerised choice task suitable for adolescents with BESD was required for

use in the current research project. Aspects of previous discounting tasks (e.g., the task, the reward type, the reward size and the duration of the delay) and adjustment procedures (including the IP method) were considered regarding their suitability for use in a task for adolescents with BESD.

According to several education staff at the school, many pupils exhibited resistance to academic tasks. Therefore presenting them with arithmetic problems was likely to result in poor participant recruitment. Additionally, the type of reward to be used required consideration. Tokens and monetary rewards have been commonly used (e.g., Estle et al., 2007), through exchanges for consumables such as sweets and toys. Other research has involved the use of large hypothetical delays and rewards, such as rewards ranging from \$1 to \$1000 and delays ranging from 1 month to 50 years (Rachlin, Raineri & Cross, 1991). Although there has been evidence of similarities between discounting hypothetical and real rewards (e.g., Johnson & Bickel, 2002) it was important to consider the degree to which adolescents with BESD would understand the reward options on offer. Such large hypothetical values and delays may be difficult to understand for pupils with poor numeracy skills. Furthermore, it was possible that participants with ASD would have difficulty understanding the notion that the rewards and delays were hypothetical due to deficient comprehension of make believe scenarios (as identified by the DSM-IV-TR, 2000).

As outlined in chapter 1, many researchers have employed a hyperbolic function to summarise choice and calculate indifference points across a range of delays to predict choice responding at delays that have not yet been tested.

Much of this research involved generalisation of many individuals' indifference points across a number of different delays. However, Ainslie (1975) and Neef, Mace and Shade (1993) noted considerable variation between individuals regarding rates of discounting. The present research therefore aimed to measure discounting on a case-by-case basis and more general discounting behaviour across a range of delays. Given the large variation of characteristics likely to exist in such a mixed sample, data were expected to be highly variable and, as the intention was to measure and plot empirical data points rather than predict discounting, the application of a hyperbolic function was considered unnecessary in this research.

Furthermore, in consideration of previous research (e.g., McCown, Johnson & Shure, 1993; Mitchell, 2004; Robles & Vargas, 2007), it seemed reasonable to question whether increased deliberation and awareness is involved in self-controlled responding. More specifically, whether more thinking time is involved in making more self-controlled choices and less thinking time involved in making more impulsive choices. Therefore, an additional requirement of the choice task was that it should record response times.

Experiments 1 and 2 therefore, set out to (a) determine whether a choice task designed for use in the present research was suitable to measure delay discounting in adolescents with BESD, and (b) whether response times were larger when participants choose larger delayed rewards and smaller when participants made more impulsive choices.

## **2.2 General Method**

### **2.2.1 Participants and Setting**

Ethical clearance was obtained from the Faculty of Science Ethics Committee at the University of Plymouth 17 April 2007 (see Appendix A) to authorize the research to commence. Consent to conduct research at the school and regular consultation with the senior therapist on project specifics prior to testing was given by the Principal of the school. In addition, passive consent of parents/carers of each pupil was obtained in April 2007 (Appendix B) and September 2008 (see Appendix C). Pupils whose consent was not given were excluded from participation (a total of three throughout the entire research project). Each pupil was required to provide active consent prior to each individual experiment to enable their participation in each study (see Appendices D, G, J, N, R, T, X and Y for consent forms used).

The population sampled in the present research were pupils from a residential school for boys with behavioural, emotional and social difficulties (BESD), ranging in age from 11 to 19 years. The boys presented varied diagnoses including Autistic Spectrum Disorder (ASD), Aspergers Syndrome, Attention Deficit Hyperactivity Disorder (ADHD), Conduct Disorder (CD), Oppositional Defiant Disorder (ODD), Post-traumatic Stress Disorder (PTSD), Bipolar personality, Global Learning Difficulties, Dyslexia/Specific Learning Difficulties (SpLD), Moderate Learning Difficulties (MLD), Severe Learning Difficulties (SLD), and Language and Communication Disorders. The school was residential, with several pupils enrolled on 52 week placements. Given the mixed sample of individuals included to participate in this research, pupils were

unsystematically selected for each experiment by the senior therapist and the head of education at the school.

The school was divided into two separate sites. Both were set in quiet rural locations, and they were within twenty minutes' drive of each other. One site accommodated 11 to 16 year old males, and consisted of two education blocks and a large residential unit. The other site catered for 16 to 19 year old males and consisted of a main building used predominantly as accommodation, with a number of classrooms adjoining. This site also had an animal husbandry unit, two small education blocks and a small independent residential unit.

Before the research began, the experimenter assisted pupils during lessons and residential time for a period of 3 months to familiarise herself with both pupils and staff, and become used to the daily routine. On completion of CRB checks and Child Protection training the experimenter worked with pupils individually and in groups. Initial work with pupils was overseen by experienced staff at the school and the experimenter carried a two-way radio at all times. Testing sessions were carried out in a number of locations throughout the school as no particular space was dedicated for work such as that in the present project, and therapy rooms were often used on an ad hoc basis.

### **2.2.2 Materials**

A measure of impulsive choice was required for the present research that was simple and easy for adolescents with varied learning needs and communication difficulties to use. During the researcher's familiarisation with pupils, it appeared many found novel tasks difficult to cope with. However, many pupils played



computer games, and regularly swapped and tried new games, so they had experienced novelty this way. Consequently, to limit participants' anxiety in performing a novel task and to facilitate understanding of task requirements the research team proposed the use of a simple computer game-type choice task.

The CCT (Computer Choice Task) was programmed using Visual Basic software and presented to participants (in all experiments involving the CCT) on an Ergo<sup>®</sup> Preceptor 4 laptop (Pentium 4 processor using a Windows XP operating system). A small number of participants presented motor control difficulties and so rather than using a keyboard, all individuals participating in studies involving the CCT used a Logitech<sup>®</sup> Attack 3 joystick to make choices towards left and right monetary rewards.

The CCT developed for the present project was named "Space Warrior". The appearance was based on that of simple traditional computer games, such as the highly popular Space Invaders game designed by Tomohiro Nishikado and released by Taito in 1978 (Bowen, n.d.). The CCT used simple, attractive graphics to deliver a number of choice options from which participants could choose between SS (Smaller Sooner) and LL (Larger Later) reward values. It was necessary for the program to interest the target population, but not to be so engrossing that it would provide an unrealistic behavioural measure of impulsive choice, and increase desire to be absent from lessons or other activity.

Participants were required to shoot one of two spaceships presented in each choice trial. One was worth a more immediately available reward value and the other was worth a fixed value that was available after a delay. Spaceship lights

moved and a spaceship sound effect was played during each choice trial. Due to the game-like characteristics, the CCT was referred to in the brief, debrief and instructions as a "spaceship computer game". To increase visual interest, the screen picture displayed additional graphics. These included a centrally positioned moon that remained stationary whilst asteroids rotated and moved slowly around the screen, stars that twinkled (see Figure 2.1) and small rockets that flew steadily across the screen. However, these additional graphics were removed after Experiment 1 as they proved to be too distracting for participants. These additional objects never moved into the line of gun fire and they could not be shot at or hit by the gun. Headphones were also available to minimise possible external noise, however no participant used them throughout the research project as external noise was minimal.

It was considered important for the delay and reward to be both real and familiar to participants. Money is unique as a generalised conditioned reinforcer that can be exchanged for other desired items and activities. A monetary system was already in use at the school, whereby pupils received "talents" (points) that were recorded and later could be exchanged for money (1 talent was equivalent to 1 penny) and used to pay for desirable items and school activities that were approved by staff, parents or guardians. Money was therefore regarded as a reward likely to be reasonably well understood and liked by the participants. However, some members of staff at the school expressed the view that some of the boys had difficulties understanding the value of money. To facilitate understanding of the reward in the CCT, one spaceship point was equivalent to one penny. To further help participants understand reward amounts, monetary rewards were presented as figures and represented visually in a box under

each spaceship (Figure 2.1). The appropriate number of one-penny (1p) coins were placed on the table by the side of each spaceship to additionally display the reward amount.



Figure 2.1 An example of the initial screen presentation in "Space Warrior".

Furthermore, as the monetary reward was real and each monetary reward chosen had to be given to the participants as payment to keep, it was necessary to consider reward amounts. Given the boys' experience of earning small monetary amounts at school (between £0 and £5 each week), the reward values for each choice trial were a minimum of 0 pence and a maximum of 10 pence, as twenty trials could earn them a maximum of £2 within a single testing session. This reward amount could be covered within the research budget and

was considered likely to be large enough that participants would not make corner solutions by choosing all SS rewards.

On starting up the program, an initial set up screen was shown where parameters could be set. A gun at the bottom of the screen was always positioned closer to the SS reward to visually represent the time to reach, shoot and be given the rewards in each choice trial (although participants were not told how long it would take to obtain each reward). For example, as can be seen in Figure 2.1, it would take longer to obtain the 10p (LL reward option) than the 5p (SS reward option).

Once a choice was made (by moving the joystick either towards the left reward or the right reward), the gun at the bottom of the screen moved slowly along the bottom of the screen to a pre-set position vertically in line with the chosen reward. The duration for the gun leaving its original position to reaching the LL reward was equivalent to the delay for that particular series of choice trials (30 seconds in Experiment 1, for example). The duration for the gun leaving its original position to reaching the SS reward was fixed at 1 second for all experiments using the CCT. The gun fired immediately when it was in position and the shot took 1 second to reach the target. The inter-trial interval was fixed at 3 seconds for all studies in which the CCT was used. In an attempt to limit the duration of the CCT and time away from routine activities, each choice was limited to 60 seconds (illustrated by a countdown timer in the middle of the screen in Figure 2.1).

Consequently, the duration of each trial depended on whether the participant chose the LL or SS option and the amount of time they took to make each choice. For example, in Experiment 1 with a delay to the LL reward of 30 seconds, if the participant took 1 second to choose the reward, the LL choice trial would take 35 seconds (1 second to choose, 30 seconds delay to LL, 1 second to shoot the target and 3 seconds inter-trial interval), and the SS choice trial would take 6 seconds (1 second to choose, 1 second delay to SS, 1 second to shoot and 3 seconds inter-trial interval).

On completion of each series of choice trials in the main task, a screen appeared with "Great Score! Your total was:\_ (Press fire to end the game)" and an audio recording saying "Great Score" was played. To ensure choice was not affected by colour preference, both spaceships were given the same colour, and spaceship colours randomly altered between each choice trial. Additionally, to control for right or left side bias, SS and LL reward options were presented randomly (as assigned by the computer program) on either side of the computer screen.

Each option presented to the participants, each choice made, and participants' response times (RTs) were recorded by the program. Two transparent containers (9cm high by 7cm diameter) were used, of which one was designated as the experimenter's and the other as the participant's (positioned nearest to the designated individual throughout the session). The experimenter's container initially contained 200 one-penny coins (although this changed to 180 one-penny coins after Experiments 1 and 2) and the participant's container was initially empty and positioned next to the laptop. The

experimenter removed the amount of money chosen in each trial during the main task from her container and placed it into the participant's container.

A score sheet was used to record the total monetary amounts participants obtained at each delay (similar to the form shown in Appendix M) and participants were required to sign a consent form at the beginning of the session (see Appendices D, G, J, N, R, T, X and Y). Written instructions and a brief and debrief (see Appendices E, G, H, I, J, K, L, O, S, U and Z) for the task were given to participants on a handout. They were also repeated verbally to ensure understanding.

### **2.2.3 Design and Procedure**

A within-subjects design was used in which each participant was presented with a series of choice options (either five practice followed by twenty main choice trials in Experiments 1 and 2, or four sets of six choice trials in the remaining experiments using the CCT. See individual experimental sections for details). Participants were briefed on the nature of the study, invited to sign a consent form prior to participation, and reminded of their right to withdraw. Participants were given typed instructions which were also read aloud by the experimenter. The general and practice instructions were read and participants received the practice task. Following the practice, the experimenter read the main task instructions and participants then received the main task. The instructions, the brief and debrief used simple vocabulary and were clear and concise to facilitate participants' comprehension of the task. Participants were asked if they had any questions before the start of both the practice and main tasks. Providing the experimenter was satisfied that participants understood the task

following the practice, participants received the main task. Participants had no previous experience of the novel CCT, but were familiar with using computers.

The delayed amount remained constant (10 pence) throughout each CCT testing session. The immediate reward amount always started as half the delayed amount (5 pence) and was adjusted depending on the participant's previous choice. This initial adjusting procedure was designed with the aim of converging on a point of indifference that a participant could reach and sustain within a fixed number of choices. For this reason, the adjustments were generated using a procedure similar to the DAA (Du, Green & Myerson, 2002). However, as the current research presented participants with smaller monetary reward amounts and more than six choice trials per delay (in Experiments 1 and 2), the adjustment procedure was modified to suit the present project. This involved halving the immediate (SS) amount (this value was rounded by the computer program to whole pennies) and either adding or subtracting it to the original immediate value to generate the next immediate amount (Table 2.1).

Table 2.1 *Adjustments of SS values when SS is previously chosen and when LL is previously chosen.*

SS value presented	Choose SS (- half SS) Next SS value =	Choose LL (+ half SS) Next SS value =
10p SS	5p (- 5)	10p (+ 5)
9p SS	4p (- 4.5 (5))	10p (+ 4.5 (5))
8p SS	4p (- 4)	10p (+ 4)
7p SS	3p (- 3.5 (4))	10p (+ 3.5 (4))
6p SS	3p (- 3)	9p (+ 3)
5p SS	2p (- 2.5 (3))	8p (+ 2.5 (3))
4p SS	2p (- 2)	6p (+ 2)
3p SS	1p (- 1.5 (2))	5p (+ 1.5 (2))
2p SS	1p (- 1)	3p (+ 1)
1p SS	0p (- 0.5 (1))	2p (+ 0.5 (1))
0p SS	0p (- 0)	*0p (+ 0)

*Note: \*Exception to the rule would be when a participant reaches 0p SS versus 10p LL. If 10p LL is chosen in this instance, the next SS value would be increased to 1p SS rather than continuing at 0p SS for the remaining trials to permit participants to reach higher indifference points if desired.*

Specifically, if the participant chose 5p (pence) immediately in the initial 5p (more immediate) versus 10p (delayed) option, the next option generated would be 2p (immediately) versus 10p (after a delay); if the participant chose to have 10p after a delay their next choice would be 8p (immediately) versus 10p (after a delay). Figure 2.2 illustrates this and several other examples of different pathways of adjusted choice options that might be experienced during the CCT.



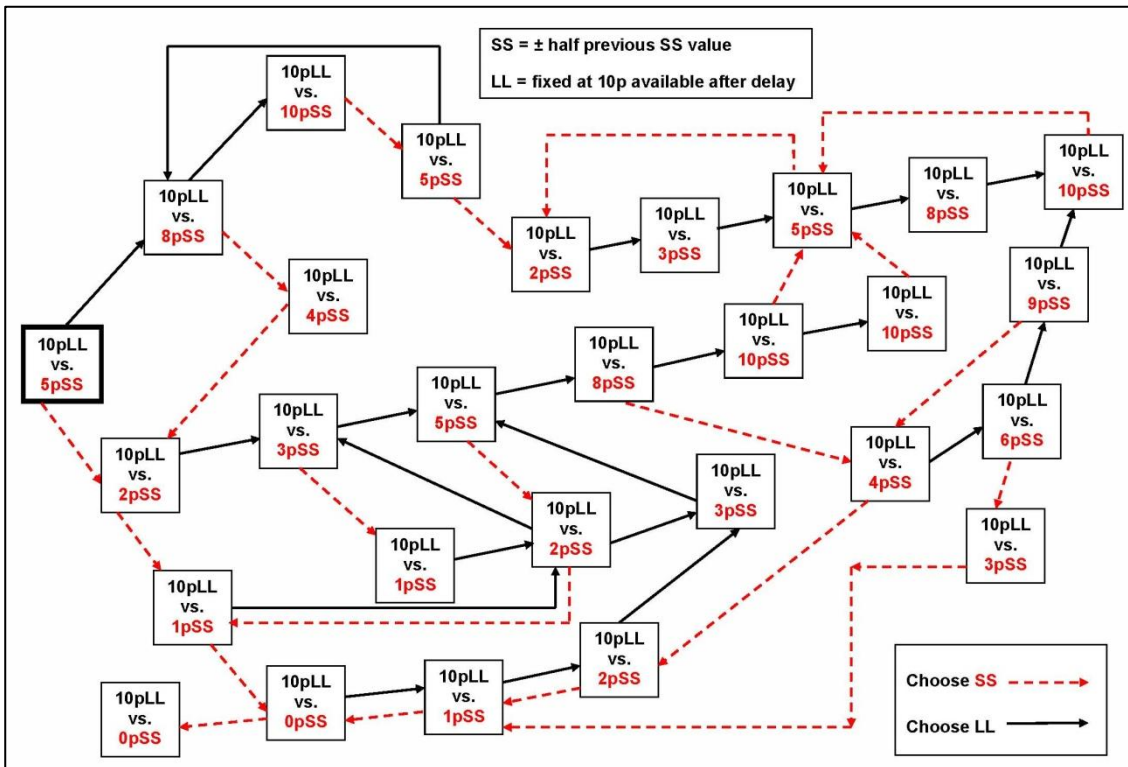


Figure 2.2 Flow diagram of possible pathways proposed for adjusted choice options presented and chosen in the CCT.

Solanto et al. (2001) and Hoerger and Mace (2006) presented participants with practice trials to familiarise participants with the choice task. Specifically, Hoerger and Mace used a series of unrewarded forced choice trials where each participant experienced the same specific aspects of the task. Therefore, in accordance with these studies, participants in the current research project were presented with a series of practice trials to reduce anxiety and facilitate understanding.

In Experiments 1 and 2 practice tasks required participants to press a button on a joystick to make the gun move left or right according to a random sequence determined by the computer program. No choice was required and no monetary

rewards were received during the practice trials. For the remaining experiments however, practice trials were identical to choice trials in the main task, but involved smaller delays (see individual experimental chapters for more details).

For the main choice tasks participants were presented with two spaceships worth different monetary amounts. Participants moved the joystick left or right in the direction of the spaceship they wanted to choose. The gun would then move across the bottom of the screen towards the chosen spaceship to a point vertically in line with it and fire a shot to destroy the spaceship. The reward value associated with the spaceship would be added to the total score and the next choice trial would commence. This would be repeated until all the trials (specified in each experimental chapter of the current thesis) had been completed.

Each option presented, each choice made and the associated response times (in milliseconds) were recorded automatically by the computer. Response Times (RT) were recorded from the presentation of the choice to the point at which the participant moved the joystick left or right. The experimenter debriefed each participant after completion of the CCT and the one-penny coins were changed into larger denominations. For all experiments (except Experiments 3 and 4 involving university students) each participant was then escorted back to his living area or classroom and relevant staff were given the participant's monetary reward by the experimenter for the total amount scored. The member of staff signed to confirm receipt of the money and added to the participant's money box. The student participants in Experiments 3 and 4 were debriefed at the end of the experiment, the experimenter changed the one-

penny coins into larger denominations and given their monetary reward for the total amount they had scored after the testing session.

## **Experiment 1**

### **Suitability and Effectiveness of the CCT (Part I)**

#### **2.3 Introduction**

As stated in section 2.1, a novel delay discounting task was required to explore impulsive choice in a mixed sample of adolescents with BESD as efforts to obtain a previously used discounting task were unsuccessful. Several details of discounting tasks and their relevance to work in the current project have been reviewed earlier. However, several details remain to be considered, such as the appropriate delay and the number of choice trials required to obtain a valid IP.

As reported in chapter 1, the DSM-IV-TR (2000) identifies attention deficits as associated with diagnoses of ADHD and ASD. As some of the participants in the present research were diagnosed with ADHD and ASD, it was necessary to give careful consideration to the task duration. Solanto et al. (2001) presented ADHD and control participants with a series of choices between two squares: one square worth 1 point was available after 2 seconds; one square worth 2 points was available after a delay of 30 seconds. Hoerger and Mace (2006) however, used a single delay condition of 60 seconds for the LL reward.

As discounting studies generally involve the presentation of more than one delay, order of presentation may affect participants' choice responding. For example, with an ascending order of delays and a participant new to the task,

data obtained from the initial delay condition is likely to be different to data gained in the last delay condition due to increasing familiarity with the task. Additionally, in the event that all participants receive delays in the same order, order effects, including decrease in motivation across delays, are not easily identified. Some studies, for example Du et al., (2002) presented delays in ascending order, however more recent experiments have randomised the order of delays (e.g., Estle et al., 2007) to reduce order effects.

Research by Robles and Vargas (2007) suggested that due to the graduation of ascending and descending presentation of delays, participants are likely to be aware of their previous choice and thus choose more consistently, whereas randomised delays would produce more valid absolute points of indifference. However, the schedule of delay presentation requires consideration of research intentions. In the case of small participant samples and seeking to assess the validity of a discounting task it might be more appropriate to present delays in a fixed order as, although order effects might be present, it is likely that they would affect participants similarly, whereas the effects of a random sequence would be more difficult to identify.

As outlined in previous work reviewed in section 1.5, the number of choice trials presented to participants to obtain indifference points has differed between studies. For example, Robles and Vargas (2007) presented participants with 240 choice trials, whereas Simpson and Vuchinich (2000) presented participants with 30 choice trials at each of 8 delays in two sessions, resulting in 480 choice trials. Mitchell's standard-alternative procedure used 23 choice trials at each delay and Du et al.'s DAA used six choice trials for each of four delays.

However, according to Kowal, Yi, Erisman and Bickel (2007), between five and fifteen choice trials (approximately 11 questions) were sufficient for consistent responding to be produced and an IP to be obtained at a single delay using Richards, Zhang, Mitchell and De Wit's (1999) Double-Limit Algorithm.

As reported in chapter 1, inattention and impulsivity are characteristics commonly presented by adolescents with BESD. Therefore it was essential to administer as few choice trials as possible to reduce the risk of fatigue effects on pupils' responding. For this reason, Du et al.'s (2002) DAA might have been attractive as it involved only six choice trials at each delay. However, with such a small number of choice trials it is possible that invalid data are produced, with initial choices being critical as individuals are quickly forced towards reaching their point of indifference.

In an alternative procedure, Solanto et al. (2001) presented ADHD and control children with five practice forced-choice trials in which they were advised which option to choose to ensure participants experienced both options, followed by two sets of twenty choice trials. A total of 25 choice trials at a maximum delay of 30 seconds corresponded to approximately a 20 minute testing session. It was considered that this was a duration likely to be suitable for individuals with difficulties in sustaining attention for extended periods of time.

Experiments 1 and 2 were pilot studies designed to assess whether a novel computerised delay discounting task (the Computerised Choice Task: CCT) provided a suitable measure of delay discounting in a mixed sample of adolescents with behavioural, emotional and social difficulties (BESD).

Additionally, the association between response time (RT) and choices made toward more immediate smaller rewards (RTSS) and delayed larger rewards (RTLL) was explored to determine whether the data were consistent with the suggestion that self-controlled choices involved more awareness and deliberation and hence took longer than impulsive choices.

## **2.4 Method**

### **2.4.1 Participants**

Participants in Experiment 1 consisted of a mixed sample (Table 2.2) of ten male adolescents between the ages of 11 and 17 years (with a mean age of 13 years and 6 months,  $SD = 1.84$ ) presenting a range of behavioural, emotional and social difficulties (BESD). All participants were enrolled on residential placements at the school.

Table 2.2 Age and diagnosis information for participants in Experiment 1.

P No	Age (years)	ADHD	ASD	AS	CD	BESD	Schizophrenia
P1	15	<b>X</b>	x			-	
P2	17					-	<b>X</b>
P3	14			<b>X</b>		-	
P4	13		<b>X</b>		x	-	
P5	13		<b>X</b>			-	
P6	15		<b>X</b>			-	
P7	13					<b>X</b>	
P8	14	<b>X</b>				-	
P9	11	<b>X</b>				-	
P10	11					<b>X</b>	

*Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Asperger's Syndrome (AS), Conduct Disorder (CD), Primary diagnosis (X), Secondary diagnosis (x), Associated difficulties (-).*

### 2.4.2 Materials

For a detailed description of general materials used see section 2.2.2 of the present thesis. In accordance with Hoerger and Mace (2006) and Solanto et al. (2001), participants were presented with a series of unrewarded forced choice practice trials. Following the practice trials, a screen appeared with "Well Done! That is the end of the practice trials. Let's get ready to rumble with the main task..." and an audio recording saying "Well Done" was played. The experimenter then pressed a button on the joystick to begin the main task.

### **2.4.3 Design and Procedure**

Experimental testing sessions were carried out after school to comply with the academic curriculum and pupils were invited to participate during periods of free time to accommodate after-school activities and routine responsibilities. Pupils were invited to participate in the research, taken to a room where the equipment was set up and given a consent form to sign (see Appendix D). Participants were then given a brief and instructions about the experiment (see Appendix E). See section 2.2.3 for details on the general design and procedure used in the current project.

Given the comparable characteristics of the current work to that of Solanto et al. and Hoerger and Mace, it was considered beneficial to adopt some of the features of their choice tasks and apply them to the CCT in the current project. In consideration of task duration and participants' potential attention difficulties, a single delay condition of 30 seconds (similar to Solanto et al.) was used for the LL reward in Experiment 1. In addition, as in Solanto et al., participants were presented with five practice trials followed by 20 choice trials in the main task.

To effectively prepare participants for making choices in the main task, the delay to the LL reward in the practice task was also fixed at 30 seconds. Given that participants were limited to 60 seconds to make each choice, and the largest trial duration was 35 seconds and the smallest trial duration was 6 seconds, it was anticipated that for Experiment 1 a single testing session containing 25 choice trials could take a maximum of approximately 40 minutes and a minimum of approximately seven minutes to complete.



In response to previous research, it seemed reasonable to propose that with a total of 20 choice trials at a single delay, participants could become used to the adjustments and reach a point at which they could respond consistently (a feature stipulated in several discounting studies, e.g., Simpson & Vuchinich, 2000; Richards, Zhang, Mitchell & De Wit, 1999).

Each of the five practice choice trials required participants to press a button on a joystick to make the gun move left or right according to a random sequence determined by the computer program. On completion of the practice task, participant's questions were answered and the main task commenced. The main task involved a series of 20 choice trials between a fixed LL reward of 10p available after a delay of 30 seconds and adjusted SS reward values available after 1 second.

## **2.5 Results**

As the SS reward value was adjusted (depending on participants' choice) to gradually converge on an IP, the IP for each participant was calculated as the average (mean) value taken from the final ten SS reward values presented. Since practice trials were forced choice, it was likely that there might be some effects of transitioning to choice trials. Therefore, participants were likely to choose most consistently in the last half of the task.

Figure 2.3 shows the SS reward values presented to each participant for each choice option, with each SS value chosen highlighted in red. Practice trials were forced choice and therefore not included in analysis. A lower IP indicated that

more SS rewards and fewer LL rewards were chosen, and hence the more impulsive a participant's choices were deemed to be.

As can be seen in Figure 2.3, IPs varied considerably between participants. Of the ten participants, four (P1, P4, P8 and P10) revealed corner solutions, persistently choosing the LL (10p) reward until they were presented with a SS reward of 10p (equivalent to the LL), at which point they chose the SS, reducing their next SS choice option back to the initial SS choice option of 5 pence. Focussing on data from P1 in Figure 2.3 for example, on choice trial number 1 he chose the LL, so the value of SS increased on trial 2. On choice trial 2, he also chose the LL option, so on trial 3 the SS increased to the maximum amount of 10p. Participant 1 continued to choose the LL on trial 3, so the SS reward value remained at 10p on trial 4. However on trial 4 he chose the SS, so on trial 5 the SS decreased to its initial amount of 5p. To summarise, if the SS increased or remained the same in the proceeding choice trial, the participant had chosen the LL reward in the previous trial, if the SS decreased in the proceeding trial, the participant had chosen the SS reward in the previous trial.

According to data in Figure 2.3, P8 maintained a consistent pattern of responding (i.e. made the same choices time after time) across the twenty trials (three LL reward choices followed by one SS reward choice), choosing a total of fifteen LL rewards and five SS rewards. It is important to note that although P1, P4, P8 and P10 chose several SS rewards, they could not be characterised as impulsive because the adjusting procedure in these instances had brought the SS amount to 10p, and thus equal to the LL reward amount. Although P8 received the maximum monetary amount possible (£2.00), he could have

responded more efficiently (obtaining the maximum amount within minimal duration) by choosing the LL reward until the SS reward was equal to the LL amount, choosing SS in this instance and repeating this response pattern across the twenty choice trials. For example, P1, P4 and P10 produced more efficient responding across trials, with the exception of choice trials 3 (P1), 9 (P4) and 6 (P10), in which participants chose the LL option when both SS and LL amounts were equal (see Figure 2.3).

Figure 2.3 shows that a number of participants chose LL when presented with a choice option of 10p LL or 10p SS (as indicated by the SS reward value equalling 10 in two adjacent choice trials). It is possible that participants were exploring the adjusting procedure when initially presented with this choice. However, when P2 was asked why he made that choice, he stated “killing more time going for the further away one”, but he later showed some frustration with the gun taking longer to get to the higher amounts.

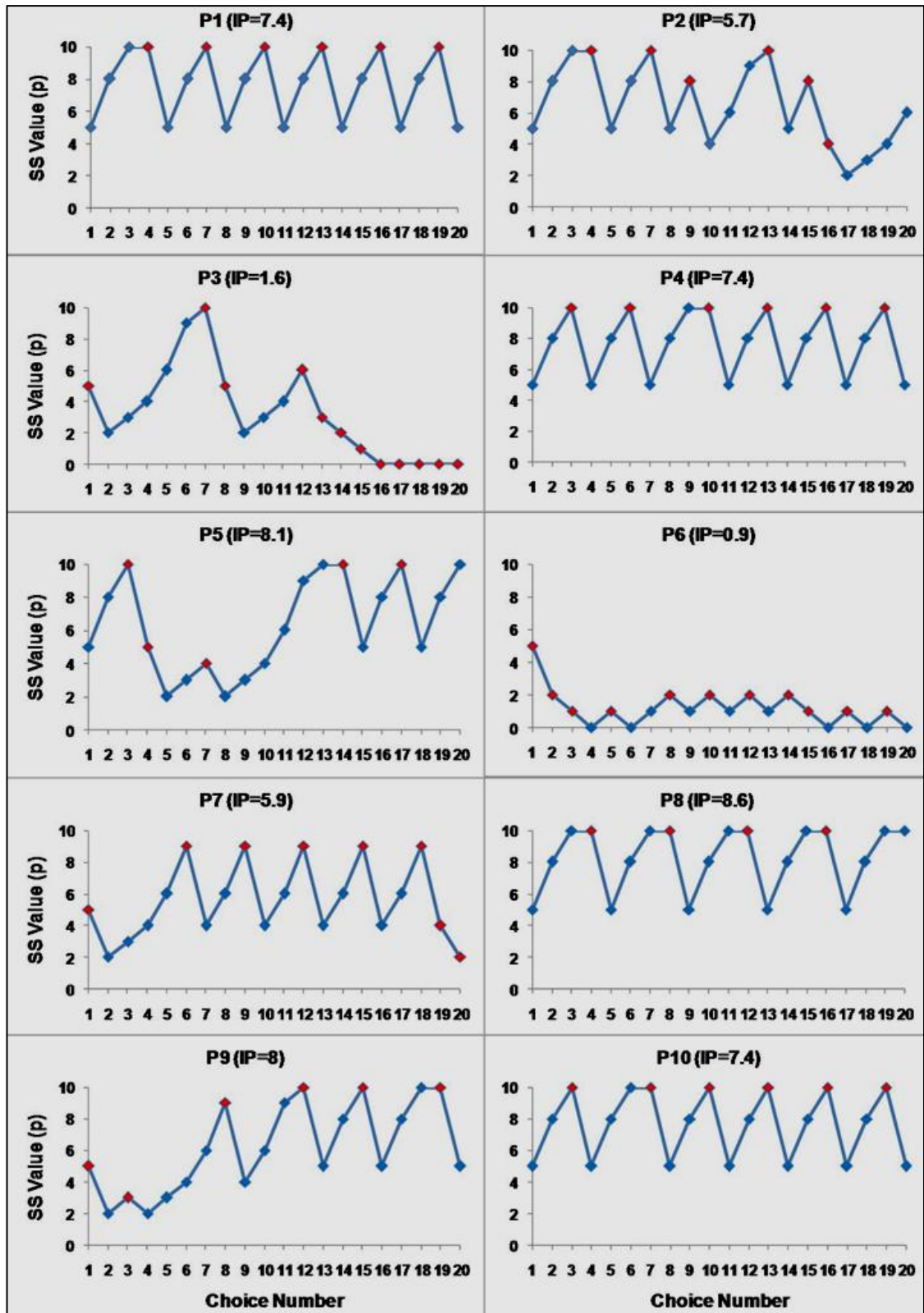


Figure 2.3 Smaller sooner (SS) reward values (pence) presented to participants with each SS value chosen highlighted in red.

Participants 2, 3, 5, 6, 7 and 9 chose the more immediate smaller (SS) reward on several occasions. Participant 3 chose the delayed (LL) reward in eight trials until choice trial number 12, at which point he stated "I can't be bothered with this, £1 will do thank you". This participant continued the session choosing the SS reward option (the more impulsive choice) in the remaining eight choice trials, eventually choosing 0p for the more immediate reward rather than having to wait 30 seconds for 10p. A similar high rate of discounting was produced by P6, and therefore he obtained a low IP of 0.9. Staff expressed initial concerns regarding his ability to understand the computer task. Although, it seemed his understanding improved throughout the task, his comprehension of amount size was likely to have affected the results, as when asked which number was bigger out of 2 and 10 he replied "I don't know". However, he correctly identified that 10 was larger than 1 and data for P6 in Figure 2.3 shows he consistently chose the SS suggesting he understood the delay, otherwise a more varied pattern of responding might have been expected.

During the session P1 and P4 asked questions about objects and buttons on the joystick, and made suggestions as to how the experimenter should improve the CCT. Both participants fidgeted and became bored (for example, playing with the controls and repeatedly trying to shoot the rockets), looked around the room and told the experimenter that they were aiming for the highest amount of money. It appeared that these participants quickly understood the adjustment procedure and knew exactly what to do to get the most amount of money.

Participant 5 was uncertain and nervous initially, but increased his confidence throughout the session and became bored (wanting to shoot other objects on

the screen). As with P6, staff expressed a concern that P5 would have difficulty understanding the task, however, Figure 2.3 shows, he explored the adjustment procedure initially and eventually chose consistently, suggesting sufficient understanding of the task. Participant 7 expressed that he was highly motivated by the money, however obtained a relatively average IP of 5.9. Participant 8 asked lots of questions, but was very focussed on the task and rapidly understood the adjustment procedure. During the task he expressed interest in shooting other objects (such as the asteroids and rockets) and laughed when he chose the long delay over the short delay when the amounts were equal (to which the experimenter did not react). After the task, P8 told the experimenter that he was bored but explained that it could be more boring if it went even more slowly.

Participant 9 tried to make the gun move faster by playing with the joystick during the task and stated he was bored quickly, but he liked seeing the money accumulate in his container. Previous to the study, staff mentioned that P10 could present highly challenging, often impulsive behaviour and expressed difficulties in finding rewards suitably motivating for him, including money. This was consistent with his lack of interest in the task, however he appeared highly motivated by the build up of money in his container and subsequently produced responding to obtain an IP of 7.4 (more self-controlled than impulsive).

Overall, the task and its associated rewards appeared engaging, motivating and understandable for most of the participants (the only exception was participant 6 who appeared to have difficulties understanding reward values). Data in Figure 2.3 show that some participants (specifically P2 and P3, and P6 and P7 slightly)

appeared to increase their rate of discounting towards the end of the task, suggesting possible fatigue effects of experiencing too many choice trials at the same delay. Given the large differences in the number of choice trials used in previous research, the question of whether the number of choice trials was effective in establishing an IP at a single delay arose. Since a modified version of Du et al.'s DAA was used with 20 choice trials rather than six (as used in the original procedure), the IP for each participant was also calculated for the first six trials (Table 2.3) in order to determine whether participants had reached a similar IP within six trials as they had after 20 choice trials.

Table 2.3 *Mean SS values taken from the final ten and first six SS reward values in Experiment 1.*

P No	IP from last 10 trials	IP from first 6 trials
P1	7.4	7.7
P2	5.7	7.7
P3	1.6	4.8
P4	7.4	7.7
P5	8.1	5.5
P6	0.9	1.5
P7	5.9	4.8
P8	8.6	7.7
P9	8	3.2
P10	7.4	7.7

In comparing the IPs in Table 2.3, IPs for P1, P4, P6, P7, P8 and P10 were similar at the initial six and final ten choice trials, two participants (P2 and P3)

increased discounting (chose more impulsively) towards the end of the task and two participants (P5 and P9) decreased discounting (made more self-controlled choices) towards the end of the task.

Figure 2.3 illustrates that six of the ten participants (P1, P2, P4, P7, P8 and P10) were responding consistently by trial number 6. Of the two participants who increased their discounting in trials towards the end of the main task, P2 had previously responded consistently (Figure 2.3) across eight consecutive trials (from choice trial numbers 1 to 8). Furthermore, P6 responded consistently from choice trial numbers 7 to 14 and P7 responded consistently across fifteen consecutive trials (from choice trial numbers 4 to 18). P3 did not respond consistently until the last five choice trials and P9 started responding more consistently after choice trial number 6.

Although corner solutions were reached in some cases, it could be argued that the adjustment effectively converged on each participant's IP, with sufficient choice trials to reach stable response patterns. Participants 1, 4, 8, and 10 were highly consistent in their responding throughout the session. Although participants 2, 6, and 7 achieved relatively consistent responding, they became less delay tolerant in the final few trials.

Participants' response times were recorded and, although highly variable, Figure 2.4 indicates a slight increase in mean RT as participants' IP increased suggesting participants making more self-controlled choices were more likely to respond at a slower rate than participants choosing more impulsively.



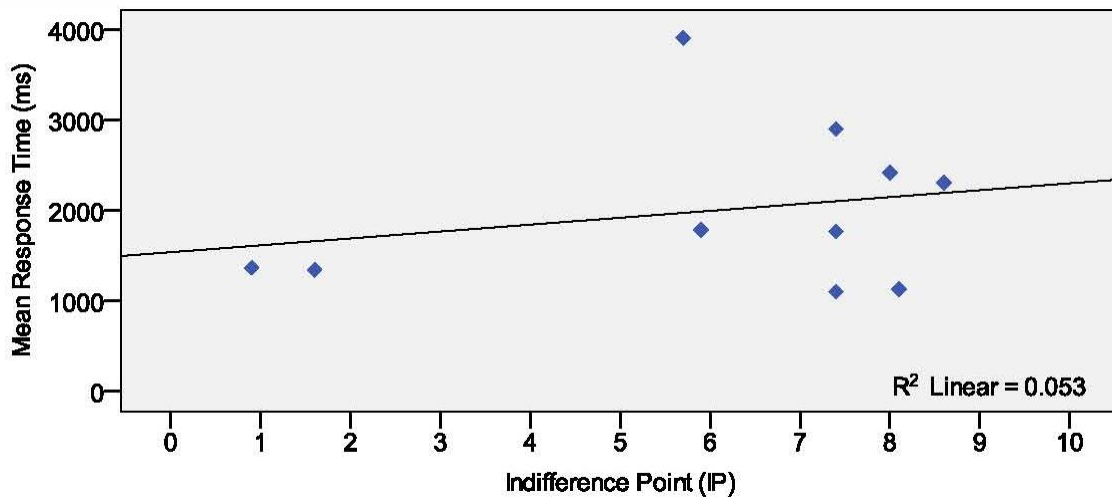


Figure 2.4 Mean Response Times and Indifference Points obtained from each participant across the final ten choice trials.

Mean RT, mean RTSS and mean RTLL were calculated for each participant from all the choice trials in the main task. According to analysis using Shapiro-Wilk (given the small participant samples, Shapiro-Wilk was more appropriate than Kolmogorov-Smirnov to test for normality) and histogram distributions, mean IP was found to be negatively skewed and mean RT and mean RTLL were positively skewed. Transformations of the data were unsuccessful, therefore these data were analysed using non-parametric tests.

Spearman's rho revealed no statistically significant correlations between IP and RT (Table 2.4). Unsurprisingly, a significant positive correlation was found between mean RTSS and mean RTLL across all participants (Table 2.4), indicating that if a participant's RT when choosing an SS reward was small, their RT when choosing an LL reward was similarly small.

Table 2.4 Spearman's rho correlations between indifference points (IP) and response time (RT) towards more immediate (SS) and delayed (LL) rewards.

Measure 1	Measure 2	$r_s$	$p$	$n$
Mean IP	Mean RT	.04	.91	10
Mean IP	Mean RTSS	-.08	.83	10
Mean IP	Mean RTLL	.17	.65	10
Mean RTSS	Mean RTLL	.77	.01*	10

Note: \*Correlation is significant at the  $p < .05$  level.

Mean RT for LL and SS choices (calculated from each participants' mean RTLL and mean RTSS across the 20 choice trials) was smaller for RTLL ( $M = 1936\text{ms}$ ,  $SD = 1108$ ,  $n = 10$ ) than RTSS ( $M = 2254\text{ms}$ ,  $SD = 991$ ,  $n = 10$ ). This is illustrated in Figure 2.5 below, in which all participants (with the exception of P2 and P10) had smaller mean RTLL than RTSS, indicating that participants made faster decisions when choosing delayed rewards.

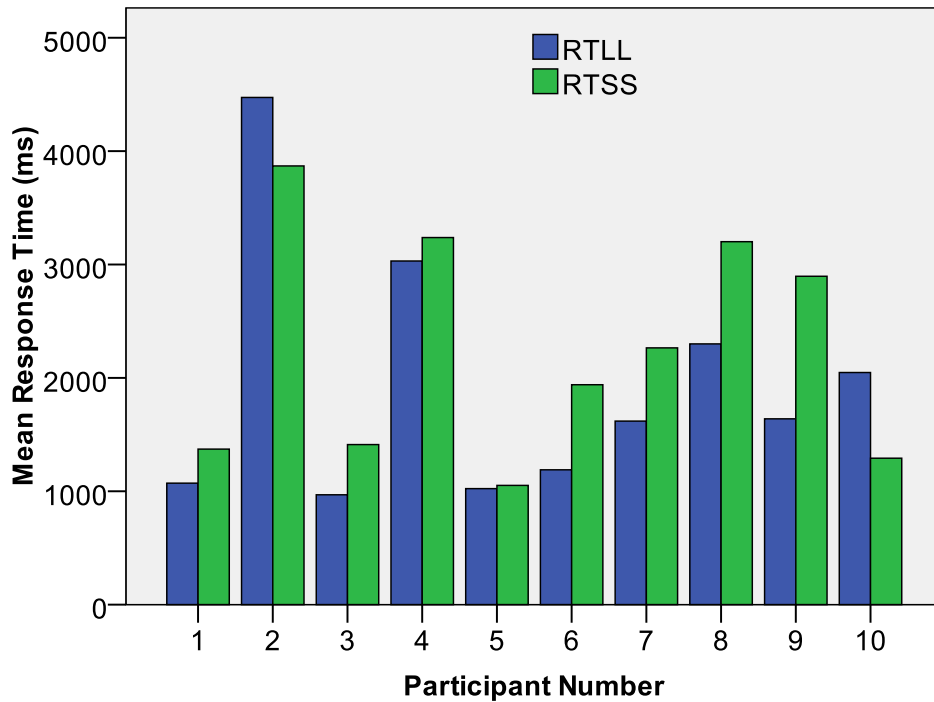


Figure 2.5 Mean response times for choices made towards LL and SS reward options for each participant across the 20 choice trials.

Given the high toleration of the 30 second delay, participants chose the SS reward less often. Therefore, mean RTSS was obtained from a smaller number of trials than mean RTLL (Table 2.5).

Table 2.5 The number (*n*) of SS and LL rewards chosen by each participant (*P*).

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Total
SS <i>n</i>	6	6	12	6	5	11	8	4	6	6	70
LL <i>n</i>	14	14	8	14	15	9	12	16	14	14	130

Since mean RTLL deviated from normal distribution, a Wilcoxon signed ranks test was performed to determine whether the difference between mean RTSS and mean RTLL was statistically significant. Results revealed the difference

between RTLL ( $Mdn = 1628.92$ ) and RTSS ( $Mdn = 2102.24$ ) was not statistically significant:  $z = -1.48$ ,  $p = .14$ ,  $r = -.47$ .

However, the result that response times to the LL rewards were faster than those made to the SS (more impulsive choices) was surprising in relation to previous research. Therefore, RT data were further explored to determine whether RT increased as participants came closer to their point of indifference. Figure 2.6 shows the response times for each choice made by each participant. The times highlighted in red indicate SS reward choices, those in blue indicate LL reward choices.

Figure 2.6 shows the large variability between participants' response times from one choice to the next. In accordance with his highly varied choice responding (seen in Figure 2.3), P2 produced the largest and most fluctuating RTs across the twenty trials. P3 generally responded the quickest to each option. The periods of increased RT for P8 coincided with points in Figure 2.3 where he was presented with the SS choice option of 10p. It appeared that participants who responded most consistently across trials had less variable response times (in particular P1, P6 and P10). Four participants' RTs were large in the initial choice trial followed by a decrease in RT for several subsequent trials. For P3, the RT was largest at choice number 12, at the point when he explained that £1 was enough and he could not be bothered. As can be seen in Figure 2.3 and 2.6 however, he continued the task choosing the SS reward (impulsive choices) quickly.

The data presented in Figure 2.6 indicate that some participants had long RTs at points in which they were likely to have been unsure of the effect the choice would have on the next choice. For example, P1 had a large RT in choice number 4 where he was presented with SS 10p versus LL 10p option on a second time. It is possible that this participant wanted to choose the SS option, but was unsure of the consequences it would produce for reward values in the following choice. This was similar for P2 and P8 in their third choice trial, and for P9 in choice trial number 12. The 10p SS versus 10p LL option was presented a total of 45 times throughout Experiment 1 with participants choosing the SS option on 32 (71 percent) of these occasions.

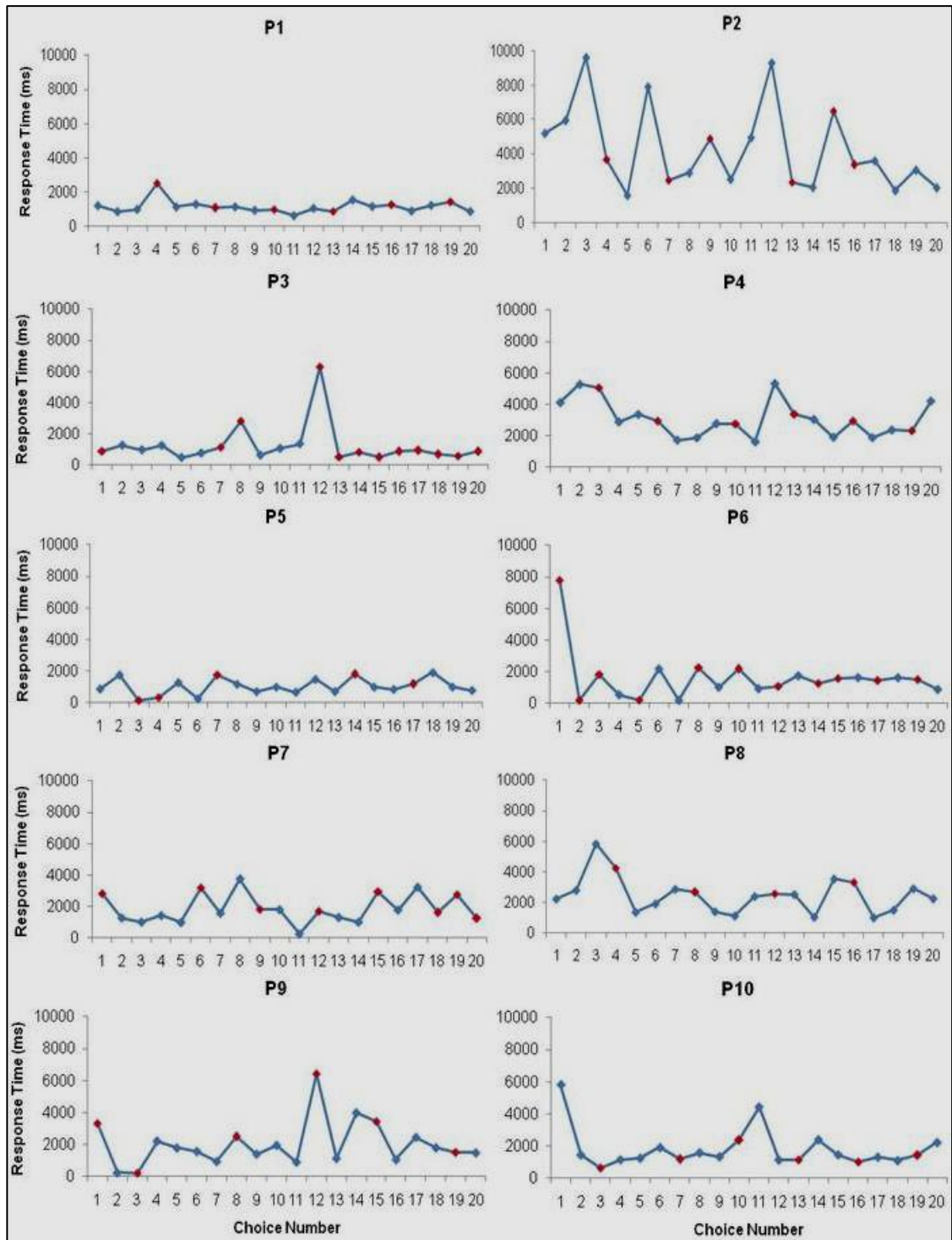


Figure 2.6 Response times (ms) for each choice made by each participant with SS choices marked in red.

Given this large percentage of SS choices in choice options involving equivalent reward amounts of 10p and the observation that RTs appeared long in several of these instances (Figure 2.6), it is possible that this may have affected RT data. Therefore, instances involving equivalent reward amounts of 10p were excluded and mean RTSS and RTLL data were re-calculated and re-analysed. Four participants (P1, P4, P8 and P10) chose the SS option only when they were presented with 10p SS versus 10p LL, resulting in RTSS data from six participants only, reducing the power of the comparison. However, results still showed that overall mean RTSS was larger ( $M = 2268\text{ms}$ ,  $SD = 1367$ ,  $n = 6$ ) than RTLL ( $M = 1843\text{ms}$ ,  $SD = 1000$ ,  $n = 10$ ).

## 2.6 Discussion

Experiment 1 produced highly varied responding, as regards both participants' IPs and their RTs on the CCT. Four participants revealed corner solutions and consequently obtained the maximum total reward amount, but some participants discounted the LL reward, with P6 discounting at a high rate. The CCT, the adjusting procedure, the delay and the reward amounts appeared to be understood sufficiently well by all participants with the exception of P6, whose understanding of reward amount was questionable. Prior to conducting this research there was some concern over whether participants' numerical comprehension would be sufficient and the demands of the task too high. However, the results indicated that the task and numerical amounts were appropriate for the majority of participants. The monetary reward was sufficient to produce both self-controlled choices (as participants were willing to wait the 30 second delay to receive the reward) and impulsive choices (as participants became less delay tolerant). Some participants reported enjoyment in seeing

the money accumulate in their container. It is possible that participants 3 and 6 were less motivated by the monetary reward or were simply less delay tolerant as they discounted the LL reward on several occasions.

A concern prior to running the study was whether participants would find the CCT sufficiently engaging, as individuals with BESD are reported to have difficulties maintaining attention. During the testing session, a number of participants were distracted by the additional graphics (predominantly the asteroids and rockets) that were presented on the computer screen. Participants' responding was likely to be affected by this, and therefore it might be desirable to remove them for further testing. Although some participants mentioned that the task was boring and provided suggestions on how to make it more interesting, they were willing to wait 30 seconds for the larger reward amount. Four participants made corner solutions, choosing the 10p reward value throughout the 20 trials, and therefore were highly tolerant of the 30 second delay, indicating an increase in the length of delay might be required in order to observe the point at which tolerance of delay is exceeded.

Four of the ten participants produced consistent responding throughout. According to IPs obtained from the last ten and the first six choice trials (Table 2.3), P1, P4, P6, P7, P8 and P10 had reached their IP by trial number 6, suggesting that the total 20 trials presented to them were unnecessary. It is possible that the boys who responded consistently throughout (P1, P4, P8 and P10) might have developed satisfactory patterns of responding from which they were able to accurately predict the consequence of each choice, therefore avoiding the possibility of being presented with less valuable options in future



trials. Furthermore, three of the ten participants (P2, P6 and P7) responded consistently before the last 10 choice trials, but appeared to discount the LL reward more towards the end of the 20 trials, suggesting that 20 trials at the same delay was too many. Similarly, P3 increased his discounting rate considerably in the last 10 trials suggesting possible fatigue effects of too many choice trials. However, it was evident that two of the ten participants (P5 and P9) needed the 20 trials to allow them time to manipulate their choices, understand the adjustment more fully and thus eventually make consistent choices around their IP.

If only six choice trials had been used (as in the DAA, described in section 1.5.4), it is likely that these individuals' IPs would have been forced promptly to a point of indifference of questionable validity. However, for the participants who appeared to reach their IP early on in the task, it is possible that their rate of discounting increased in later trials due to fatigue effects resulting from the presentation of additional choice trials (e.g., P3 in Figure 2.3). Since the IPs were calculated from SS values presented in the final ten choice trials, it is therefore possible to question the validity of IPs obtained for these participants. Fewer choice trials might have yielded more valid IPs.

Indifference points for participants who reached corner solutions (chose all LL rewards until the SS reward amount was equal to LL) were calculated as 7.4 for P1, P4 and P10, and 8.6 for P8. However, these IPs do not effectively reflect participants' responding as participants 1, 4 and 10 had rejected several SS values of 8p, indicating that their IP should have been between 8 (the largest SS amount rejected) and 10 (the largest SS amount chosen). Having never

been offered 9pSS, it is unclear whether these participants would have chosen 10pLL or 9pSS, but it seems reasonable to propose 9 as a more realistic representation of their IP than 7.4. Similarly, for P8 the largest SS amount he rejected was 10p and the largest SS amount he chose was 10p, suggesting that the IP for P8 should have been 10 rather than 8.6. Therefore, the calculation of IPs for participants such as those mentioned here, required consideration and an alternative calculation was necessary to provide valid IPs.

In accordance with previous research by Robles and Vargas (2007) and by Mitchell (1999), it was expected that participants would either take longer to make self-controlled choices (by choosing the LL reward option) and take less time to make more impulsive choices (by choosing the SS reward option), or that participants' RTs would increase the closer they came to their IP. However, data on response times showed the opposite; although the difference was not significant, participants took longer when making impulsive choices and were faster at making self-controlled choices. Several participants had larger RTs when choosing the SS reward option when presented with the 10p SS versus 10p LL reward option. It is possible that this affected the mean RT data, as in 70 percent of cases the 10p SS reward option was chosen (see Figure 2.3). This therefore might explain why RTs were larger for choices toward the SS rewards (the more impulsive choice). However, data were re-analysed with RTs from trials involving equal reward amounts of 10p excluded, and the same pattern was found.

In addition to the difference between RTSS and RTLL, there were no statistically significant correlations found between IP and RT. It is possible that

this was due to the underpowered analysis resulting from the small sample size and heterogeneity of the sample. One clear finding was that several participants reached corner solutions; tolerating the 30 second delay and showing no discounting throughout the 20 trials. It seems reasonable to suggest that such highly delay-tolerant responding might be decreased through increasing the delay to the LL reward. Comments made by participants suggested that it might be wise to remove the additional graphics (the asteroids, rockets, moon and stars) that appeared to be distracting them during completion of the CCT. Clearly the task was engaging enough to maintain their attention and removing these features might provide a less variable assessment of behaviour. In order to address this issue and the high incidence of corner solutions in the present experiment, a revised version of the CCT was administered to another small sample of pupils at the school in a second experiment.

## **Experiment 2**

### **Suitability and Effectiveness of the CCT (Part II)**

#### **2.7 Introduction**

Experiment 2 was designed to assess the effect of modifications to the CCT and to further evaluate its suitability as a measure of delay discounting in adolescents with BESD. The CCT was reprogrammed to remove the additional graphics described in section 2.2.2 above (leaving only the spaceships and associated values, the countdown timer and the gun), and provide the option for the experimenter to alter task parameters. Given that four participants reached corner solutions in Experiment 1, the first aim of Experiment 2 was to determine

whether the removal of the additional graphics and an increase in delay to the LL reward would produce more discounting and fewer corner solutions.

Secondly, Experiment 1 showed some indication of possible fatigue effects caused by the presentation of repeated choice trials, with several participants reaching their IP by choice trial number 6. Therefore, it was necessary to explore whether such responding would be produced at a larger delay in Experiment 2, and to determine whether IPs could be more efficiently obtained by administering six choice trials instead of 20. This would enable delay discounting to be measured over a series of delays within shorter session durations.

As discussed in section 2.6, IPs for individuals who reached corner solutions were unrepresentative of participants' responding. In response to this, an alternative calculation was proposed for such responding and evaluated in Experiment 2. Lastly, to determine whether the unexpected results from Experiment 1 (that participants responded to more immediate (SS) rewards more slowly than delayed (LL) rewards) were replicable, Experiment 2 further investigated the relationship between impulsive choice and response time.

## **2.8 Method**

### **2.8.1 Participants**

Nine male adolescent participants, between 15 and 17 years of age (with a mean age of 15 years and 7 months,  $SD = 0.71$ ) were recruited from the mixed sample of pupils with BESD at the participating school. Participants presented a variety of diagnoses (Table 2.6), including P4 who was reported to have a

general developmental delay contributing to a range of behavioural, emotional and social difficulties. Participants had no prior direct experience of the CCT, however participants may have conversed with peers who had previously participated in Experiment 1. Participants were familiar with using computers and knew the experimenter due to the experimenter’s part-time involvement at the school.

Table 2.6 *Age and diagnosis information for participants in Experiment 2.*

Participant Number	Age (years)	ADHD	ASD	BESD
P1	16	<b>X</b>		-
P2	15	<b>X</b>	<b>X</b>	-
P3	15		<b>X</b>	-
P4	16			<b>X</b>
P5	15		<b>X</b>	-
P6	15	<b>X</b>		-
P7	16		<b>X</b>	-
P8	16		<b>X</b>	-
P9	17		<b>X</b>	-

*Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Primary diagnosis (X), Secondary diagnosis (x), Associated difficulties(-)*

### **2.8.2 Materials**

Apart from the modification to the CCT programme in removing the distracting additional graphics and adding a set-up screen to enable parameters to be adjusted and set, the materials used were the same as those detailed in section

2.2.2. Written instructions, brief and debrief for the CCT can be found in Appendix E.

### **2.8.3 Design and Procedure**

A within-subjects design was used in which all participants received the CCT. As in Experiment 1, participants received five practice unrewarded forced choice trials with a pre-reward delay of 1 second to the SS reward and a pre-reward delay of 30 seconds to the LL reward.

In an attempt to reduce the number of corner solutions, an additional modification of the CCT involved increasing the delay to the LL reward from 30 seconds to 60 seconds in the main task. The main task consisted of 20 choice trials in which participants were invited to choose between a smaller reward value available after 1 second, and a larger reward value (that remained at 10p throughout the task) available after a delay of 60 seconds. The value of the smaller reward adjusted up or down on each subsequent trial according to the algorithm described in section 2.2.3.

### **2.9 Results**

As for Experiment 1, participants' IPs were calculated as the average (mean) SS value taken from the last ten choice trials. However, in response to the unrepresentative IPs obtained by some participants in Experiment 1, IP was calculated differently for participants who had purely chosen 10p LL in the last ten trials or had only chosen SS when it was equivalent in value to the LL reward (10p) in the last ten trials. For these participants, the IP was calculated

as halfway between the largest SS amount chosen (or 10 if SS was never chosen) and the largest SS amount rejected.

The SS reward amounts presented to each participant across the 20 trials can be seen in Figure 2.7, with each SS value chosen highlighted in red. Data obtained from the five forced choice practice trials were not included in analysis. However, it is important to note that some participants expressed confusion and appeared to have difficulties progressing from the practice task to the main task possibly due to different requirements of the two tasks.

Figure 2.7 shows large variability between participants' responding. Participant 7 was the only participant to reach a corner solution, choosing 10 pence in each trial and consequently gaining the maximum monetary reward of £2 for the total twenty trials. Accordingly, the IP for this participant was calculated at 9 (halfway between 10 and 8), successfully representing his high toleration of the 60 second delay. It could be argued that this participant fully understood the options available, as when presented with options equal in value (10 pence) he consistently chose the more immediate option, making the most efficient responses throughout. This participant expressed slight confusion during the instructions, therefore to facilitate understanding the experimenter referred to points as talents (with one pence equating to one talent). During the task P7 stated that he was "just going for the highest points", thus emphasising his motivation for gaining the most amount of money. Participant 7 appeared focussed throughout and enjoyed watching and waiting for the money to be put into his container, saying "get ready" on the occurrence of the SS 10p versus

LL10p option, and he stated that the game was "too easy, but don't make it harder".

Participant 1 appeared to become bored and frustrated with the 60 second delay and, as visible in Figure 2.7, rapidly discounted the delayed reward until approximately choice trial number 13, at which point he became more delay tolerant, choosing LL rewards in the remaining trials. Participant 2 continually repeated that the task was slow and that he was tired. His gradually decreasing tolerance of the delay throughout the task can be seen from the SS values P2 was presented with in Figure 2.7. Participant 2 initially made 7 consistent choices (repeatedly making the same choices when presented with identical choice options), followed by a decrease in delay tolerance after trial 8. He became more consistent between choice trials 13 and 18, then increased his rate of discounting further in the final 2 trials. Staff voiced initial concerns regarding his ability to understand the monetary reward values, however he seemed to understand the differences in size between two numbers when questioned after the session.

Participant 3 explained that he wanted the gun to move faster, found the task easy and rather than wanting the money for himself he wanted to earn the money to give to a fellow student. On a number of trials this participant attempted to change the direction of the gun to obtain the alternate reward. As illustrated in Figure 2.7, P3 started responding consistently at trial number 9, choosing all 10p reward options after this point. Participant 4 was initially nervous and was concerned that he would not understand the CCT. However, P4's anxiety reduced as he found the task easy and became frustrated by the



60 second delay to obtain the larger reward. Figure 2.7 shows that P4 chose relatively consistently from trial number 4, but increased his tolerance of the 60 second delay, choosing all LL rewards in the final few trials.

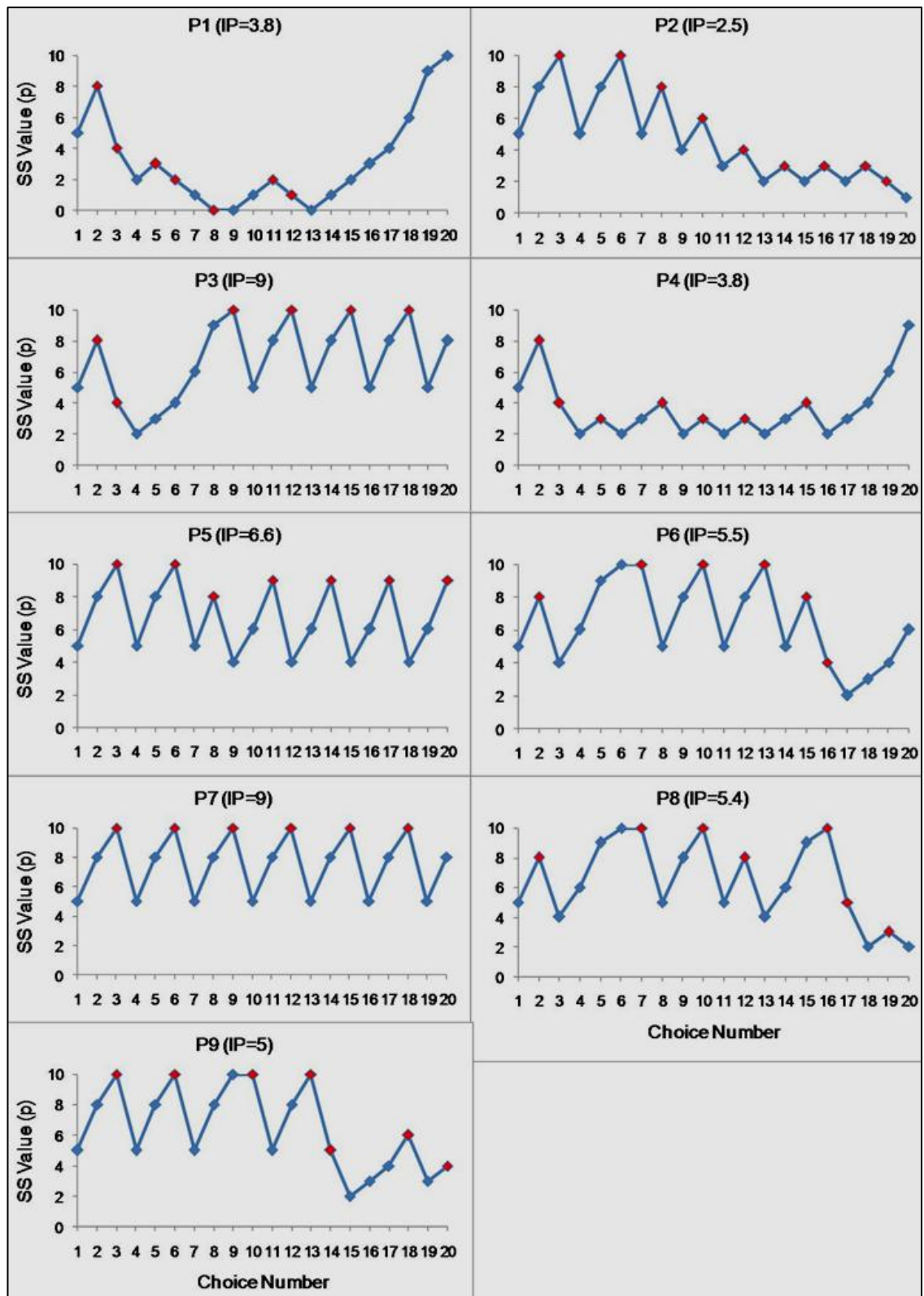


Figure 2.7 The more immediate (SS) reward values (pence) presented to each participant in Experiment 2. Each SS chosen is highlighted in red.

Participants 5 and 6 became bored very quickly (tried to play with the money, asked several questions and explored the joystick) and told the experimenter they wanted the gun to move faster. Participant 5 chose relatively consistently throughout the twenty choice trials, becoming slightly less delay tolerant on trial number 8, and then returned to responding consistently between trials 9 and 20. Participant 6 increased his tolerance of the 60 second delay in the middle nine trials, in which he consistently chose all 10p rewards. However, his discounting increased in trials 15 and 16, then decreased again, choosing all LL rewards in the final four trials.

Participant 8 seemed highly motivated by the monetary reward and enjoyed watching the experimenter place the money into his container. His responding was relatively varied, with an increased rate of discounting towards the end of the task. His most consistent choices were made between trials 4 and 11. Participant 9 was concerned initially with his ability to understand the task however, after the first few choice trials, his confidence increased and he began expressing his boredom with the task. Participant 9 chose consistently until trial number 14, at which point he became less tolerant of the delay and his rate of discounting increased.

Figure 2.7 shows Participants 2, 4, 5, 6, 7, 8 and 9 started responding consistently before or on choice trial number 6, with P5 and P7 responding consistently throughout the session. Participants 1 and 3 however, started responding more consistently after choice trial number 6. Participants 1 and 4 decreased, became consistent, then increased their tolerance of the 60 second delay towards the end of the session, and participants 2, 6, 8 and 9 chose

consistently then increased their rate of discounting in the final trials. Choice options involving rewards equal in value were presented a total of 28 times throughout Experiment 2. On almost 90 percent of these occasions, the SS reward was chosen, suggesting that participants generally made the most efficient choice by choosing the more immediately available reward.

Overall, the task and its associated rewards appeared engaging, motivating and understandable for most of the participants. Data in Figure 2.7 show that some participants (specifically P2, P6, P8, P9 and P5 slightly) increased their rate of discounting towards the end of the task. This might suggest the effects of fatigue from experiencing several choice trials at the same delay. Since the number of choice trials used in previous research has varied, the issue of whether 20 choice trials were necessary and effective in establishing an IP at a single delay was raised again. Indifference points for each participant were calculated from the first six trials (Table 2.7) and compared to those obtained from the last ten choice trials.

In comparing the IPs in Table 2.7, IPs from three participants (P1, P4 and P7) remained the same, five of the nine participants (P2, P5, P6, P8 and P9) increased discounting (chose more impulsively) in the final ten choice trials and one participant (P3) decreased discounting (made more self-controlled choices) towards the end of the task.

Table 2.7 Mean SS values taken from the final ten and first six SS reward values in Experiment 2.

P No	IP from last 10 trials	IP from first 6 trials
P1	3.8	4
P2	2.5	9
P3	9	4.3
P4	3.8	4
P5	6.6	9
P6	5.5	7
P7	9	9
P8	5.4	7
P9	5	9

All of the five participants who increased their discounting in trials towards the end of the main task had previously responded consistently (i.e., made similar choices trial after trial) across several consecutive trials: P2 and P5 from choice trial numbers 1 to 7; P6 between trials 4 and 14; P8 between trials 4 and 11; P9 between trials 1 and 13 (Figure 2.7). P3 did not respond consistently until the last 12 choice trials. Therefore, data in Table 2.7 appear to correspond to data in Figure 2.7 that indicate some participants discounted more towards the end of the task, even though they had previously responded consistently over a sequence of trials, suggesting possible fatigue effects. All participants, except P3, had either responded consistently (P2, P5, P6, P8 and P9) by trial number 6 or produced a similar IP within 6 trials to that of their IP calculated from the final ten trials (P1, P4 and P7, Table 2.7).

Response Times (RT) were obtained and used to calculate a mean RT, a mean RTSS and a mean RTLL for each participant across the total 20 choice trials. As shown in Figure 2.8 below, there was a slight negative relation between mean RTs and IPs obtained by each participant for the final ten trials, but this was not statistically significant (Table 2.9).

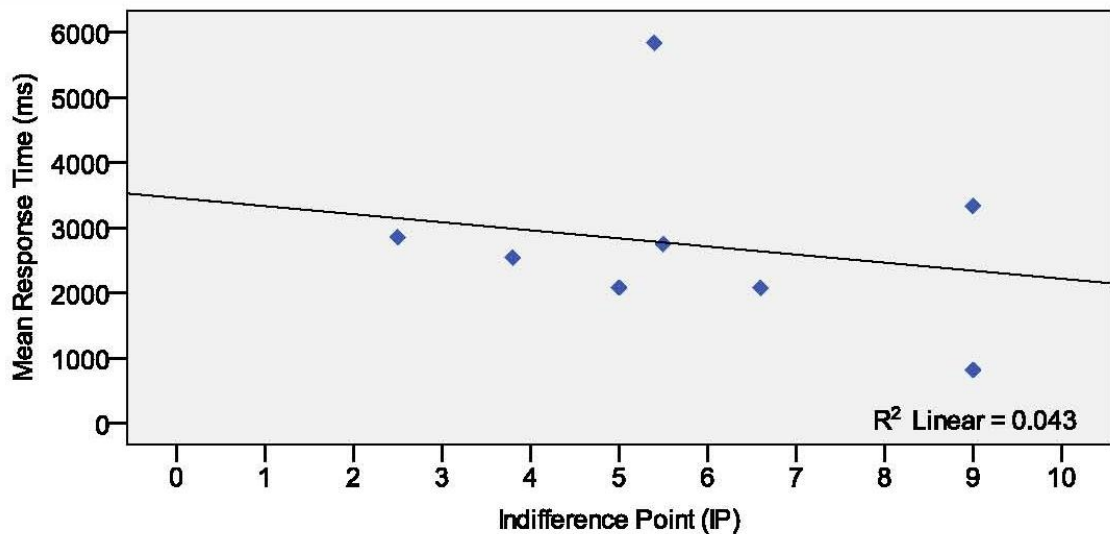


Figure 2.8 Mean response times and indifference points (IPs) obtained from each participant for the final ten choice trials.

Mean RTLL and RTSS were calculated using each participant’s mean RTLL and RTSS values across the 20 trials. Results revealed that the mean RTLL was smaller ( $M = 2807\text{ms}$ ,  $SD = 1787$ ,  $n = 9$ ) than the mean RTSS ( $M = 3571\text{ms}$ ,  $SD = 2353$ ,  $n = 9$ ) indicating that participants generally responded more rapidly when choosing delayed rewards. This responding can be seen in Figure 2.9 below, in which all participants (except P1 and P2) produced larger RTs when they chose SS rewards and smaller RTs when they chose LL rewards.

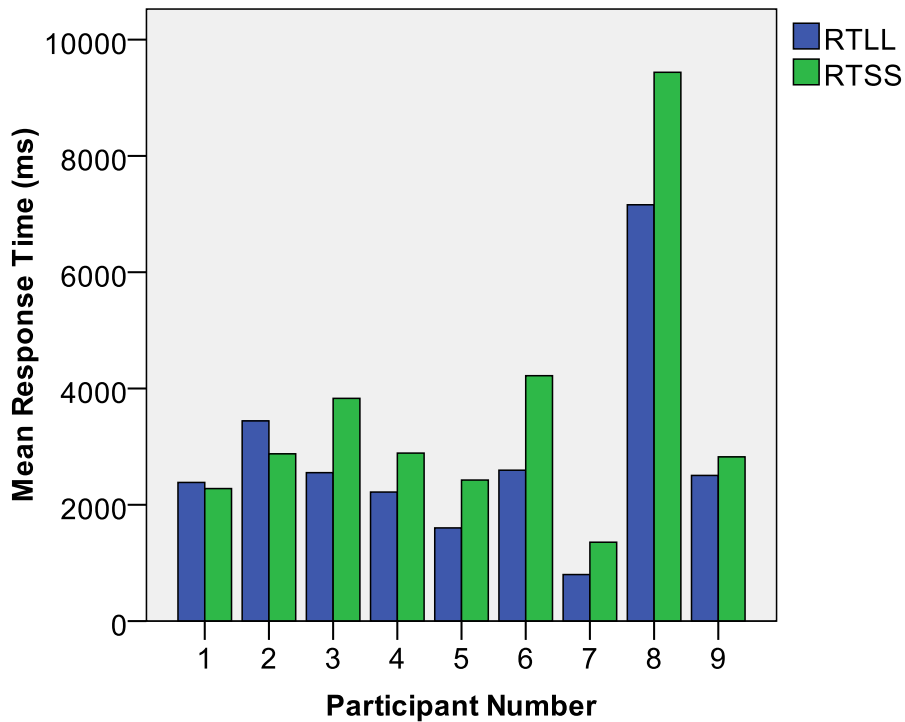


Figure 2.9 Mean response times (RT) for choices made by each participant towards LL and SS reward options.

Since the delayed reward continued to be somewhat highly tolerated, participants chose the SS reward less often. Therefore, mean RTSS was obtained from a smaller number of trials than mean RTLL (Table 2.8).

Table 2.8 The number of SS and LL rewards chosen by each participant.

P No	1	2	3	4	5	6	7	8	9	Total
SS n	8	9	6	7	7	6	6	7	7	63
LL n	12	11	14	13	13	14	14	13	13	117

According to the Shapiro-Wilk normality test (again, given the small participant samples, Shapiro-Wilk was more appropriate than Kolmogorov-Smirnov) and histogram distributions, mean RTSS and RTLL were found to be significantly

positively skewed ( $p < .01$  for both). Transformations of the data were unsuccessful, therefore data were analysed using non-parametric tests.

Spearman's rho revealed no statistically significant correlations between IP and RT, RTSS and RTLL (Table 2.9). As in Experiment 1 however, a significant positive correlation was found between the mean RTLL and the mean RTSS (Table 2.9), indicating that a participant who responded quickly when choosing the LL rewards, similarly responded quickly when choosing SS rewards.

Table 2.9 Spearman's rho ( $r_s$ ) correlations between indifference points (IP) and response time (RT) towards more immediate (SS) and delayed (LL) rewards.

Measure 1	Measure 2	$r_s$	$p$	$n$
Mean IP	Mean RT	-.20	.60	9
Mean IP	Mean RTSS	-.03	.93	9
Mean IP	Mean RTLL	-.32	.40	9
Mean RTSS	Mean RTLL	.78	.01*	9

Note: \*Correlation is significant at the  $p < .05$  level.

A Wilcoxon signed ranks test was performed and results revealed a large difference between RTLL ( $Mdn = 2505.15$ ) and RTSS ( $Mdn = 2876.78$ ). This difference was found to be statistically significant:  $z = -2.07$ ,  $p = .04$ ,  $r = -.69$ .

However, as for Experiment 1, the result that responses to SS rewards were generally larger than responses to LL rewards was unexpected; therefore it was necessary to explore the RT data further. Data in Figure 2.10 show the large variability of response times (RT) between choices and participants.



Participants 5 and 7 produced the most consistent choices (Figure 2.7) and smallest, most stable RTs (Figure 2.10) throughout the 20 trials. On the other hand, P8 produced the largest RTs of the participants. Participants 3 and 4 had relatively varied RTs across the 20 trials, however Participants 2, 6, 7, 8 and 9 had varied RTs initially which became more stable as the number of choice trials increased.

When the choice trial reached the option 10p SS versus 10p LL a number of participants appeared to produce larger RTs. Specifically, P6 produced largest RTs in choice trials 6, 7 and 10 (see Figure 2.10), at which points he was presented with the 10p SS versus 10p LL reward option (see Figure 2.7 above). Similarly, the largest RT for P8 was for choice trial 6 in which he was presented for the first time with reward options equal in value, but different in delay. It could be suggested that this might have been due to increased consideration of the consequences of this choice, as his RT in other trials presenting 10p SS versus 10p LL, were also responded to slower than other choice trials.

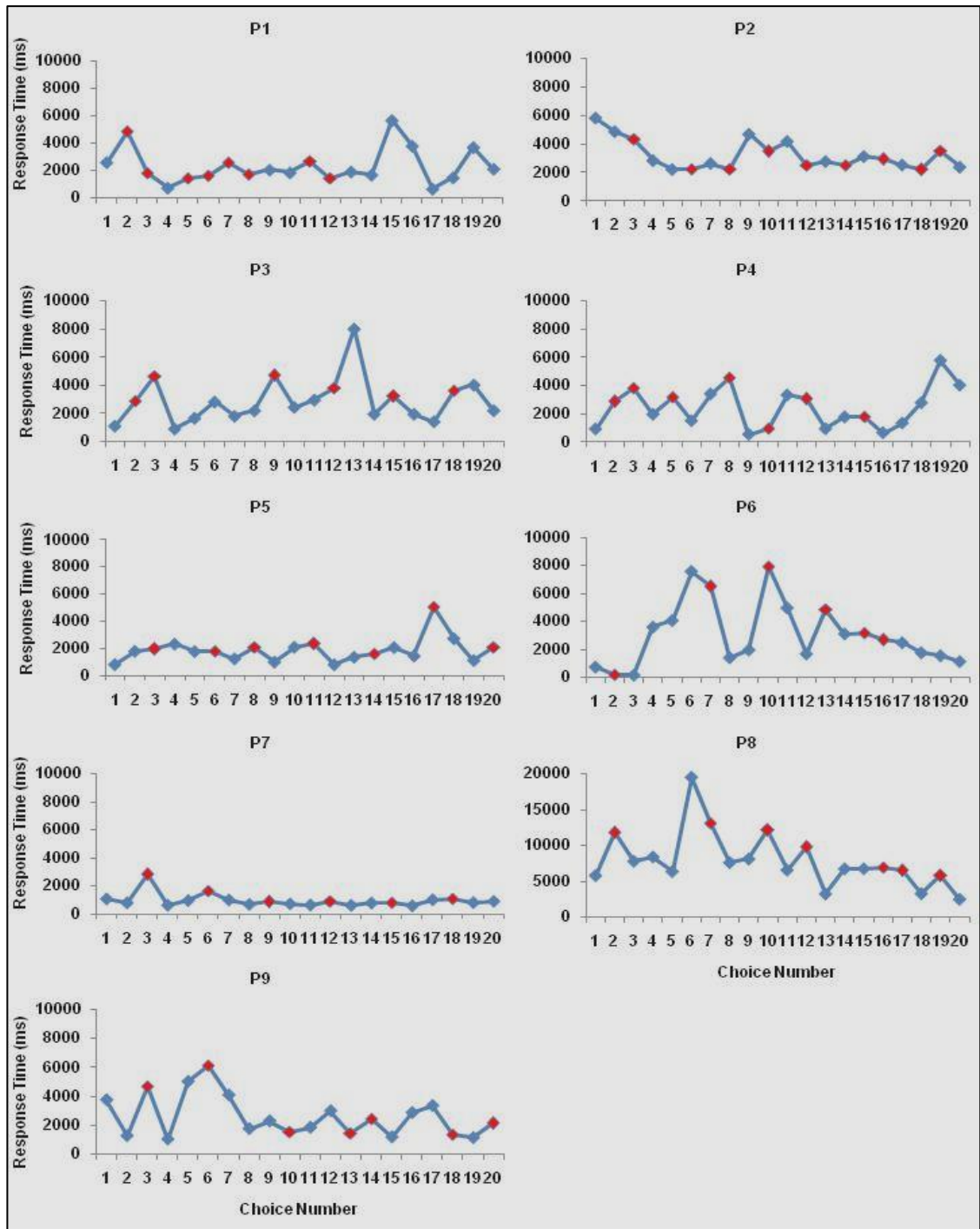


Figure 2.10 Response times (ms) for each choice made by each participant with choices towards smaller sooner (SS) rewards highlighted in red.

Although P7's RTs decreased throughout the 20 trials (Figure 2.10), this was also similar for Participant 7 who produced larger RTs when presented with the 10p SS versus 10p LL option (such as in choice trial 3). When presented with

rewards of equal value ninety percent of participants chose the SS option, possibly affecting the mean RT data produced in Figure 2.9. To determine the effect of such options on participants RTs, RT data from options involving rewards equal in size were excluded and data were reanalysed. However, results sustained those produced in Figure 2.9, with mean RTs larger on average for choices toward SS rewards ( $M = 3359\text{ms}$ ,  $SD = 2149$ ,  $n = 8$ ) than for choices towards LL rewards ( $M = 2655\text{ms}$ ,  $SD = 1489$ ,  $n = 9$ ).

## **2.10 Discussion**

Experiment 2 showed rates of discounting and response times were again highly varied between participants. Only one participant reached a corner solution, suggesting that the 60 second delay was more effective in obtaining indifference points than the 30 second delay used in Experiment 1. However, as participants' choices towards LL rewards remained relatively high, an even greater increase in the size of the delay would be necessary in future studies.

Several participants rapidly reached a point at which they chose consistently, however, their rate of discounting increased and they responded more quickly in the final trials. The data therefore showed a decrease in participants' tolerance of the delay towards the end of the session. This might suggest that these participants were averse to the length of the session (a characteristic common of individuals with ADHD: Sonuga-Barke, Taylor, Sembi & Smith, 1992). Therefore, it seems reasonable to propose that 20 trials were too many for some participants. As each participant's IP was calculated from the final ten trials, it is likely that IPs lacked validity. Several participants (P2, P4, P5, P6, P7, P8 and P9) seemed to reach a point at which they responded consistently either

before or on trial number 6, suggesting that IPs could effectively be obtained from fewer choice trials. Therefore, reducing the number of choice trials might produce more valid discounting data and response time (RT) data.

The results of Experiment 2 supported those reported in Experiment 1 with respect to response times, showing that participants responded significantly more slowly when making impulsive choices (SS rewards) and faster when making self-controlled choices (LL rewards). It was considered possible that this was affected by participants choosing the more immediate reward when presented with rewards equal in value; however re-analysis of the data provided evidence to suggest that the presentation of this option had no effect on RT. Correlational analyses revealed no significant correlations between IP and RT, possibly as a result of the heterogeneous and small sample size reducing the power of the statistical analyses.

As in Experiment 1, participants seemed to understand the task requirements, and became familiar with the adjustment procedure. Participants also appeared to understand the delay and reward amounts, and were motivated by the monetary reward. However, as several participants became less delay tolerant in the final trials, the potential use of the current CCT for repeated testing across a range of delays seems doubtful. Removal of the additional graphics used in Experiment 1 slightly reduced participants' distraction from the task. However, some participants continued to be distracted by the joystick and asked irrelevant questions throughout.

Although the adjusting procedure increased and decreased the SS values depending on the previous choice, it was discovered after the data were collected, that the SS value of 3p was incorrectly adjusted to 2p (rather than 1p when 3p SS was chosen) and 4p (rather than 5p when 3p SS was rejected and 10p LL chosen). Furthermore, it was necessary for the SS value to be increased or decreased by similar magnitudes according to each participant's previous choices, resulting in the reward options converging on a point at which the participant was indifferent between the LL and SS rewards. However, because SS adjustments were made by adding or subtracting half of the previous SS value, when participants reached larger SS values, choosing SS (e.g. 10p SS) would result in larger decreases of the SS value in the next choice trial. Therefore, participants making the self-controlled choices and reaching the option of 10p LL versus 10p SS, most participants made the logical and efficient choice of choosing SS, which they would be punished for as SS returned to the initial value of 5p (Figure 2.7). It seems reasonable to suggest that it would have been more appropriate for the SS reward to have reduced to 8p rather than 5p, allowing participants to respond more consistently between smaller fluctuations.

It was expected that participants would reach a point at which they would respond to the reward options consistently and therefore, calculating each participant's IP from the final ten SS rewards they were presented with was initially considered a valid method to obtain IPs. However it could be argued that this did not turn out to be the case, as the calculation of IPs only used SS values and therefore did not account for participants such as P1 and P4, who chose all LL rewards towards the end of the task (Figure 2.7). It is likely that IPs for these participants were larger than those actually calculated. Nevertheless,

the calculation of IP for participants who solely chose LL in the last ten trials or only chose SS when it was equal to LL (P3 and P7) was more representative of these participants' responding than simply averaging SS values in Experiment 1.

As can be seen from P7 in Figure 2.7, following the initial 5p SS versus 10p LL option, two LL choices were required to reach the 10p SS versus 10p LL option. However, on choosing the SS reward in this option, he was presented with the initial choice trial of 5p SS versus 10p LL, rather than returning to the 10p LL versus 8p SS option. In comparison, P4 in Figure 2.7 was presented with 10p LL versus 2p SS in trial number 4 and responded relatively consistently from this point, alternating his choices from 10p (when presented with 2p SS versus 10p LL option) and 3p (when presented with 10p LL versus 3p SS option). Therefore, to produce consistent responding, participants with larger IPs had to choose two LL rewards to obtain larger amounts thus requiring more effort to respond consistently. It is possible that this increased the rate at which participants became averse to the session duration mentioned earlier.

In addition, initial choices may have shaped responding, as choosing several SS values early on meant participants had to endure a slow increase of SS values by choosing the LL reward until they could reach their IP. Again, it is possible that participants were affected by such effortful responding, but having been punished for making these early choices (seeing the SS reward decrease rapidly) chose LL in the remaining trials to avoid low SS values and to continue being offered higher SS values (e.g., P3). Since IPs were calculated from SS values chosen in the last 10 trials, it could be argued that such IP data lacked

validity. In light of the present findings the CCT adjustment procedure required re-programming to ensure identical progressions between increased SS reward amounts and decreased SS reward amounts.

## **2.11 General Discussion**

In support of findings by Ainslie (1975) and by Neef et al. (1993), Experiments 1 and 2 found that there was large variation between participants' discounting. The CCT, the delay, the adjusting procedure and the reward amounts were sufficiently understood by all participants, with the exception of one participant in Experiment 1. Increasing the delay to the LL reward from 30 seconds in Experiment 1 to 60 seconds in Experiment 2 reduced the number of corner solutions, but tolerance of the 60 second delay was still high suggesting the need to increase delays further in future studies. The experimenter noted a reduction in the number of participants whose attention appeared distracted from the CCT in Experiment 2 after the removal of additional graphics included in Experiment 1. It appeared the monetary reward provided the necessary motivation for participants to choose the larger delayed reward and the CCT was sufficiently engaging for participants to produce episodes of consistent responding during the 20 choice trials.

Although a small number of participants required the full twenty choice trials to reach a point at which they responded consistently, 13 out of the total 19 participants in Experiments 1 and 2 started responding consistently either before or on choice trial number 6. Furthermore, several participants in Experiments 1 and 2 decreased their tolerance of the delay and tended to respond more quickly toward the end of the session, suggesting participants

were averse to the session duration. Therefore, it seems reasonable to propose a reduction in the number of choice trials presented to participants in future studies. Some participants had difficulties progressing from the practice (no-choice) task to the real (choice) task in Experiment 2, possibly due to the different requirements of the practice and main tasks. Consequently, providing a practice task more similar to the main task was likely to be more useful to participants in preparing and familiarising them with the main task.

In contrast to initial expectations and to findings reported by McCown et al. (1993) and by Mitchell (1999), both Experiments 1 and 2 found that participants responded more slowly when choosing the SS reward (the most impulsive). It is possible that this was because participants were highly motivated by the monetary reward but averse to the delay, and therefore expended more time considering their options when presented with increased SS values. It seems reasonable to consider the effect the CCT had on the validity of RT data in Experiments 1 and 2. For example, given the lack of similarity between the practice CCT and the main CCT participants may have responded more slowly in the initial choice trials whilst they became familiar with making choices in the main task. Furthermore, as several participants increased their discounting and responded more quickly to options towards the end of the testing session, it seemed possible that RT was affected by session duration. Therefore, RT was confounded by choice trial number and consequently the RT data in Experiments 1 and 2 lacked validity, and further research concerning the relation between response time and choice is required.



In examining the SS data obtained from Experiment 1 and Experiment 2, it became apparent that there were problems with the adjusting method. Firstly, the program was required to round adjusted amounts to whole values (rounding up when a value includes the decimal .5 or above, and down if the value includes a decimal .49 or below). However, the adjustment procedure used in Experiments 1 and 2 inconsistently rounded values, causing incorrect SS values to be presented. For example (see Figure 2.11), if a participant chose 5p SS in the initial choice option, the SS reward amount in the next trial would be calculated as half of the previous SS amount (rounded to 3p) subtracted from the previous SS value, therefore presenting 10p LL versus 2p SS in the following trial (the correct adjustment). However, if a participant chose 3p SS when presented with 10p LL versus 3p SS, the following option they were presented with was 2p. Calculated correctly, this SS reward amount should have been 1p (half of 3p SS is 1.5p (rounded to 2p) subtracted from 3p SS).

Secondly, the calculated SS adjustments decreased more rapidly than they increased, requiring more LL choices to obtain the higher SS values (see Figure 2.11 below). Therefore, it was necessary to apply an alternate adjusting method that generated similar progressions between SS reward amounts. The current adjustment procedure calculated SS adjustments using the SS value, resulting in larger adjustments occurring with larger SS reward amounts. A possible alternative to this procedure that would generate a more progressive increase and decrease of SS reward amounts, involved calculating adjustments using previous adjustments.

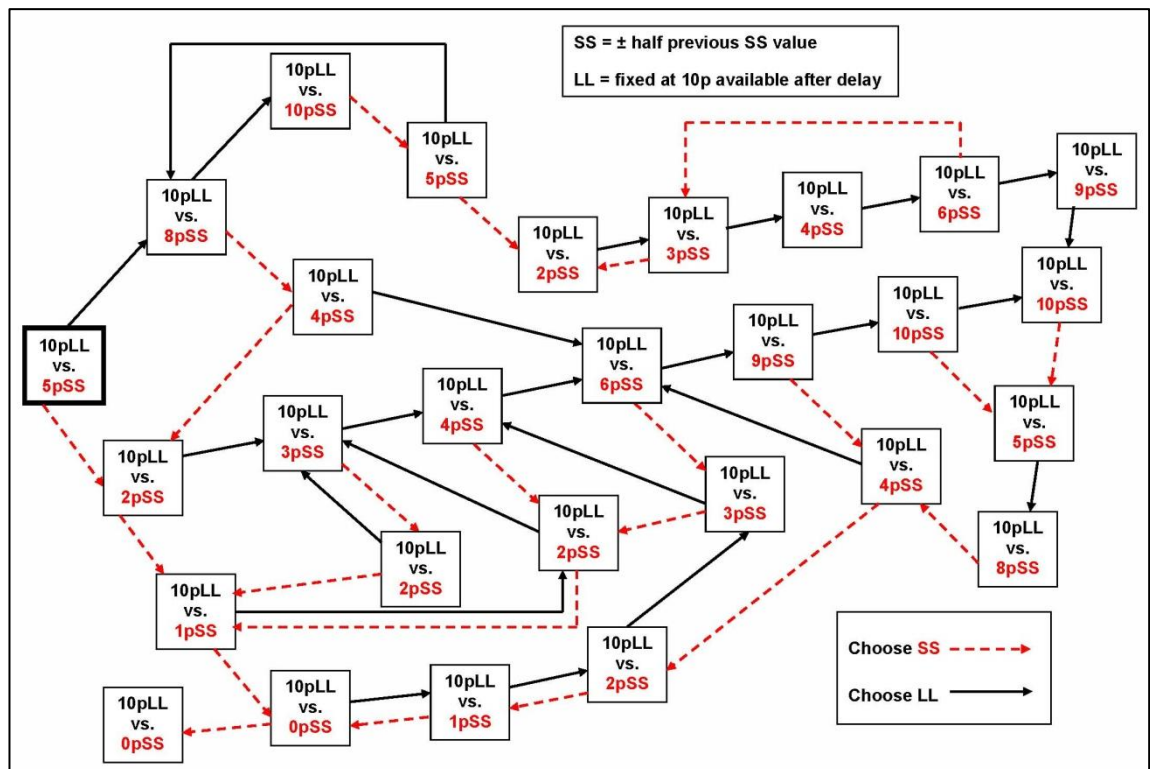


Figure 2.11 Choice options calculated by the adjustment procedure used and presented in Experiments 1 and 2.

Research by Du et al. (2002) provided evidence to support the effective use of an adjusting procedure that would enable this. As mentioned in chapter 1, a number of adjusting methods have been developed. However, the DAA designed by Du et al. took only six choice trials to converge on an indifference point at a single delay. Although initial concerns were that such small numbers of trials would force participants towards an invalid IP, the majority of participants in Experiments 1 and 2 responded consistently (i.e. made the same choices time after time) to options by choice trial 6, with evidence suggesting several participants were averse to the session duration. In consideration of research by Kowal, Yi, Erismann and Bickel (2007) and in addition to difficulties adolescents with BEDS are reported to have in sustaining attention (see section 1.2), it is reasonable to propose that IPs would be more efficiently obtained from

six trials rather than the 20 trials presented to participants in Experiments 1 and 2.

Experiments 1 and 2 provided evidence to suggest the CCT was understood and effective in producing indifference points to measure delay discounting in adolescents with BESD. Despite initial reports by staff regarding participants' lack of motivation for money, money functioned as a suitable reward and was sufficiently understood by all participants. Participants produced varied rates of discounting, with several participants producing highly self-controlled responding and others responding more impulsively (choosing more SS rewards). Increasing the LL delay produced fewer corner solutions in Experiment 2 and increasing the delay further was proposed for future studies in the present project to bracket participants' responding more precisely. However, several problems with the CCT arose and re-programming was required to obtain more valid measures of adolescents' discounting to determine the effectiveness of the CCT as a measure of impulsivity. Additional RT data was required to explore more accurately whether impulsivity was related to RT. Such evidence could provide insight into the degree of awareness involved in impulsive choice, and consequently offer evidence that impulsivity might be reduced through increased self-awareness.

## **Chapter 3: Experiments 3 and 4**

### **Modification of the CCT and Relations Between Measures of Impulsivity and Mindfulness**

#### **3.1 General Introduction**

As mentioned in previous chapters, the Decreasing Adjustment Algorithm (DAA) designed by Du et al. (2002) involved a fixed total of six choice trials to obtain an IP at a single delay. Some argue (e.g., Richards et al., 1999) that with so few trials participants are forced towards their IP, making every choice critical. However, Experiments 1 and 2 found that the majority of participants were able to reach a point at which they responded consistently by choice trial number 6, with several participants discounting more towards the end of the task. Limiting the number of trials to 6 would enable a series of IPs to be obtained across different delays, and avoid the risk of long session durations with choice options repeatedly offering the same delayed LL reward causing frustration and boredom.

In order to obtain points of indifference between the SS and LL reward options, the DAA involved calculating each SS value from the previous adjustment (rather than the previous SS value, as in Experiments 1 and 2). Therefore, throughout a series of choice trials adjustments decreased (Figure 1.8 in section 1.5.4) to converge on an IP. Du et al. presented participants with a practice task involving six choice trials and participants were permitted to alter their choice at any point during the main task, ensuring that participants were familiar with the task and adjusting algorithm, and were confident in their choices. Du et al. calculated Indifference Points (IPs) for each participant at

each delay as the difference between the last immediate reward value rejected and the last immediate reward value chosen.

The current chapter details several further studies which aimed to determine whether a procedure more similar to the DAA could be adapted and applied for use with the CCT in measuring impulsive choice in adolescents with BESD. Additionally, since the CCT was designed to measure impulsive choice, the relation between the CCT and a self-report impulsivity measure was explored. Furthermore, given that a purpose of this research project (section 1.13) was to identify whether there was an association between impulsivity and self-awareness (section 1.11), relations between impulsivity and mindfulness (section 1.12) were also explored.

### **Experiment 3**

#### **Comparison of Two Versions of the CCT and Relations Between Measures of Impulsivity and Mindfulness**

##### **3.2 Introduction**

Du et al. (2002) and many other researchers who used similar adjusting algorithms used large hypothetical monetary rewards and delays. However, it was important for the reward to be easily understood and real to create a more authentic situation and consequently produce valid data on impulsive choice in adolescents with BESD. Furthermore, it was not possible in the present research to offer participants large reward amounts as there were a) practical constraints in giving participants the real monetary reward, and b) concerns that participants would have difficulties understanding large values.

The use of large hypothetical values and delays meant that the adjusting algorithm in the experiment of Du et al. (the DAA) generally produced whole SS reward amounts (Figure 1.8, section 1.5.4). However, using smaller monetary amounts (as deemed necessary in the current study) produced fractional values (e.g., 6.40625). With the knowledge that many of the young male pupils at the school had learning difficulties, it was likely that they would have difficulties in understanding such fractional values. Consequently, the question of whether rounding the SS values would produce more valid data on impulsive choice in adolescents with BESD was raised. Experiment 3 therefore aimed to determine whether the adjustment procedure (DAA) developed by Du et al. (2002) and a modified rounded version (the DAA (R)) produced comparable results when using small reward amounts.

As mentioned in chapter 1, in addition to presenting participants with the computer task to determine rates of delay discounting as a behavioural measure of impulsivity, assessing relations with other measures of impulsivity and self-awareness was desired. Several self-report impulsivity measures have been developed (section 1.7), however, measures of self-awareness appear limited (section 1.11). As mentioned in section 1.13, it seems reasonable to maintain that mindfulness (section 1.12) is dependent on self-awareness, as it involves the non-judgemental conscious awareness of personal feelings and observations. It seemed possible therefore, that a measure of mindfulness could provide an indication of the degree to which an individual is self-aware. Furthermore, given the intention of concluding the present research with a mindfulness intervention in an attempt to develop self-awareness (section 1.13),

a mindfulness measure was considered necessary. Consequently, two self-report scales were introduced to compare the relations between impulsivity and mindful self-awareness.

Assessing the practicality of administering the discounting task and self-report scales was important to maintain limited assessment time when conducting the research with the target population. As the target population were adolescents with behavioural, emotional and social difficulties, it was also essential to use scales involving clear, simple language and design to ensure participants could answer items confidently. As the majority of the adolescents presented learning difficulties, it seemed possible that scales designed for use with children would be most suitable.

Although many self-report measures of impulsivity have been developed, the most frequently employed scales have been the BIS-11 and the Junior I.6, and it seems likely that these scales provide useful insight into the study of impulsivity. Research concerning impulsivity in specific populations may require consideration of scale items, for example adolescents with learning difficulties are likely to require a scale with a small number of items and simple language to guarantee understanding. Therefore, as with the selection of adjustment procedures in discounting tasks, deciding which scale(s) a researcher should use requires careful consideration of the population being studied.

The administration of self-report impulsivity and mindfulness measures enabled correlations to be explored between results obtained from the CCT and scores obtained from the two scales. As adolescents with behavioural, emotional and

social difficulties have difficulty in sustaining attention for long periods of time, it was important to determine the approximate duration for completing the three tasks and ensure that the tasks were easily understood by all participants.

In continuation from the previous experiments in the current project, response times (RT) were measured (in milliseconds) to determine whether participants took longer to make more self-controlled choices (choosing LL rewards) than impulsive choices (choosing SS rewards). Experiments 1 and 2 showed that on average, participants produced larger RTs when making impulsive choices and smaller RTs when making more self-controlled (LL) choices. Given this unexpected result, it was desirable to investigate whether this result could be replicated. For this reason, RT data were recorded and re-analysed using the modified CCT in Experiment 3.

In accordance with findings reported by Mitchell (1999), RTs were predicted to be smaller for more impulsive choices, and larger for more self-controlled choices. However, It was expected that indifference points obtained from the CCT would vary between participants and that participants' rate of discounting would increase as the delay to the larger reward increased. Furthermore, it was predicted that there would be a negative correlation between the self-report measure of impulsivity and indifference points, and a positive correlation between the self-report measure of self-awareness and indifference points. It was expected that scores obtained on the impulsivity self-report measure would be negatively correlated with scores obtained on the self-awareness measure the more impulsive an individual is the less mindful they are likely to be.



### **3.3 Method**

#### **3.3.1 Participants**

Rather than risk repeatedly testing the computer task on the small sample of adolescents from the participating school, twenty (fifteen female and five male) undergraduate psychology students (between 18 and 26 years of age, with a mean age of 19 years and 9 months,  $SD = 1.9$ ) at the University of Plymouth were recruited through a participation point system as part of their University course. As previous ethical clearance had only specifically been obtained to conduct research with adolescents with BESD, additional ethical clearance was obtained from the Faculty of Science Ethics Committee at the University of Plymouth 5 November 2007 (see Appendix F) for work with Undergraduate Psychology Students at the University of Plymouth.

#### **3.3.2 Materials**

Participants were provided the brief, instructions and the debrief on three separate handouts at relevant points throughout the testing session (see Appendices G, H and I). The CCT involved the use of items including the laptop, headphones, joystick and containers described in the general method section 2.2.2 (refer to 2.2.2 for details of the CCT). Scores from each participant and the total amount of money each participant had obtained from the CCT were recorded on a sheet similar to that shown in Appendix M.

It was evident from previous research (chapter 1) that the most appropriate and frequently used scales were the Junior I.6 Impulsiveness, Venturesomeness and Empathy Scale for children (Eysenck, Easting & Pearson, 1984) and the Child Acceptance and Mindfulness Measure (CAMM; Greco & Baer, 2005).

Each of the three categories (Impulsiveness, Venturesomeness and Empathy) in the Junior I.6 consisted of 23 items, and the impulsivity sub-scale had a satisfactory reliability of .74 for boys and .78 for girls (Eysenck et al., 1984). The CAMM has been reported to have good internal consistency ( $\alpha = .84$ ) and concurrent validity (Greco & Hayes, 2008). Therefore, in addition to the CCT, two self report scales were administered: the Junior I.6 Impulsivity sub-scale and the Child Acceptance and Mindfulness Measure (CAMM).

### **3.3.3 Design and Procedure**

The Du et al. procedure (the DAA) was adapted for use in Experiment 3 to present participants with values small enough to enable delivery of all rewards chosen. Given the small values used in the present research, the original adjustment procedure (DAA) designed by Du et al. (2002) produced SS reward amounts as fractional values (Figure 3.1), likely to be confusing for individuals with learning difficulties and as a result might produce invalid discounting data. Therefore, the computer choice task (CCT) used in Experiments 1 and 2 was reprogrammed to form two slightly different versions of the DAA (described in section 1.5.4): one version (referred to as the 'DAA') presented participants with the original adjusted reward values (i.e., fractional monetary amounts); the other version (referred to as the 'DAA (R)') adjusted the SS value according to the DAA, but presented participants with SS values that were rounded to the nearest whole number (bracketed SS values in Figure 3.1).

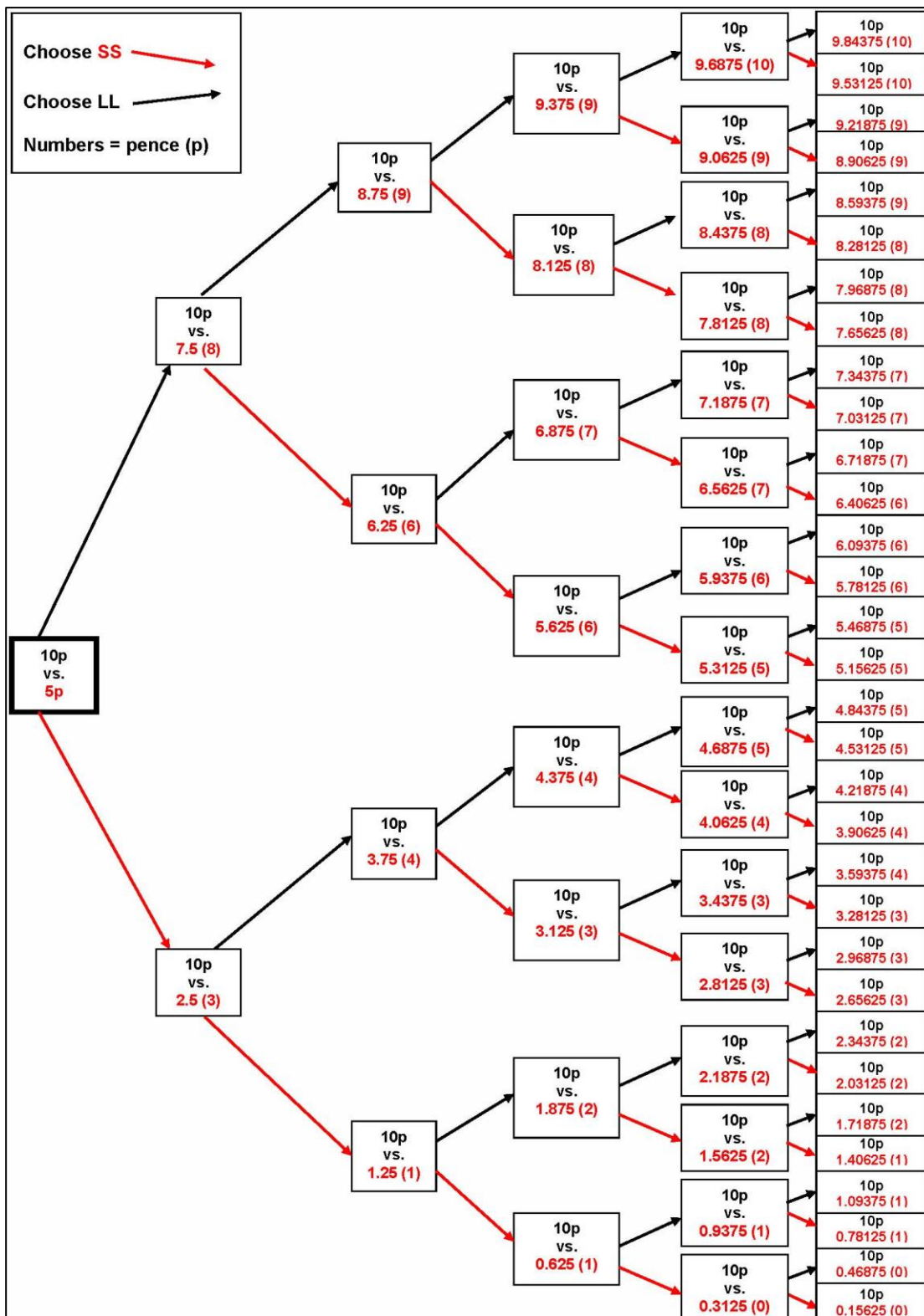


Figure 3.1 Pathways of choice options modified from the Decreasing adjustment algorithm (DAA) with true adjusted SS values in red (presented to participants in the DAA) and rounded SS values in brackets (presented to participants in the DAA (R)).

The SS values in both the DAA and in the DAA (R) were adjusted by adding or subtracting half of the previous adjustment, using the original (true) values as specified by Du et al. (2002), rather than using the rounded values presented to the participants in the DAA (R) (Figure 3.1). The adjustments were therefore determined from the original reward amount and were as similar as possible to the original algorithm developed by Du et al. It was subsequently possible to calculate and compare indifference points for both the true (taken from the original fractional values) and the rounded values. Since there were only six choice trials to obtain an IP at a single delay, it was possible to run a series of delays from which discounting curves could be produced (e.g., Figure 3.2) and IPs calculated for each delay. Indifference points could then be plotted (see Figure 1.6) to produce indifference point curves.

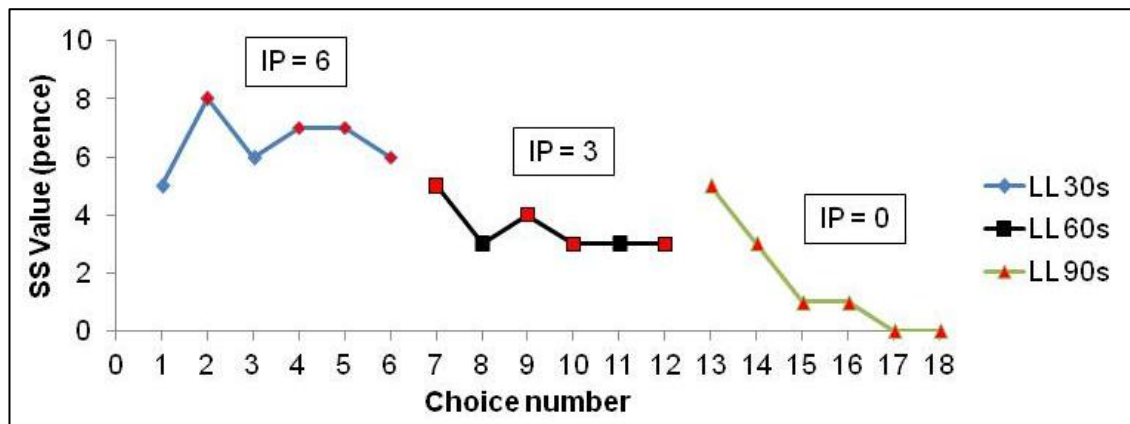


Figure 3.2 An example of a series of discounting curves produced across three delays with associated IPs displayed above (each immediate (SS) reward chosen is in red).

A within-participants design was used in which four delays to reward access (15, 30, 60 and 90 seconds), each containing six choice trials, were presented

to each participant for each of the two conditions (the DAA and the modified DAA (R)). In the case of small participant samples and seeking to assess the validity of a discounting task in a mixed sample, it was considered most appropriate to present delays in a fixed order as, although order effects might be present, it is likely that they would affect participants similarly, whereas the effects of a random sequence would be more difficult to identify. Therefore, the delays were presented in ascending order, but condition order (DAA (R) and the DAA) was counterbalanced across participants to control for order effects. Participants 1, 3, 5, 7, 9, 11, 13, 15, 17 and 19 received the DAA followed by the DAA (R). Participants 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 received the DAA (R) followed by the DAA.

The 15 second delay to the larger delayed reward was an unpaid practice in which participants were required to move a joystick in the direction of the spaceships with the associated money reward that they wanted (specifics of further CCT procedural details are available in section 2.2.3). As in Experiments 1 and 2 the practice was to enable participants to become familiar with the computer task and the adjusting parameter to reduce any effects of task novelty. On completion of the CCT participants were told the amount of money they had received and given instructions for the two questionnaires. After participants had completed the questionnaires the experimenter gave them the amount of money received in the computer choice-task. Participants were verbally debriefed and given the debrief on a handout to keep in case they wanted to contact the experimenter after the study.

During data collection in a subsequent experiment (Experiment 4), it was noticed that the intended 90 second delay appeared similar to the previous 60 second delay. The experimenter manually timed this final delay using a stop watch and discovered it to be approximately 65 seconds due to an error with the program. Therefore, rather than the intended delays of 15, 30, 60 and 90 seconds to the LL reward, delays presented in the current study were 15, 30, 60 and 65 seconds (as shown in Figure 3.3 below).

### **3.4 Results**

Since the 15 second delay condition was an unpaid practice task, these data were likely to have limited validity and were excluded from analysis. Given the small participant sample, data were checked for normality using Shapiro-Wilk as it was likely to provide a more appropriate test of normality than Kolmogorov-Smirnov. Two of the six variables (IPs at 60s and 65s in the DAA) used within the ANOVA were distributed significantly differently from normal and therefore the significance level in the ANOVA was reduced to  $p < .02$  in order to compensate for any increased risk of making a type 1 error.

The data were analysed using a 3 (delay: 30, 60, 90 second) by 2 (reward information: DAA versus DAA (R)) within-participant ANOVA. Results in Table 3.1 show that there was a medium to large statistically significant main effect of delay on IPs, but no statistically significant main effect (with a small effect size) of version on IPs. Mauchly's test of sphericity was not statistically significant for delay or version, but was significant ( $p = .047$ ) for the interaction between delay and version. Applying the Greenhouse-Geisser adjustment revealed that the interaction was small and not statistically significant (Table 3.1).

Table 3.1 *Results obtained from the two-way within-participants ANOVA in Experiment 3.*

Variable	<i>df</i>	<i>F</i>	$\eta^2$	<i>p</i>
Delay	2 (38)	24.51	.56	< .01**
Version	1 (19)	2.34	.11	.14
Delay*Version <sup>†</sup>	1.6 (29.5)	0.35	.02	.65

Note: \*\*Significant at the  $p < .01$  level. <sup>†</sup>Greenhouse-Geisser adjustment.

Table 3.2 displays the mean IPs for each version at each of the three main delays. For both versions, mean IP decreased as the delay increased, suggesting that on average participants produced discounting typical of discounting tasks. This is illustrated in Figure 3.3 revealing the significant main effect of delay and average rate of discounting across delays.

Table 3.2 *Mean Indifference Points (IP), standard deviations (SD) and number of participants (n) for each version at each delay in Experiment 3.*

DAA (R)				DAA			
Delay	Mean IP	<i>SD</i>	<i>n</i>	Delay	Mean IP	<i>SD</i>	<i>n</i>
30 seconds	5.82	2.44	20	30 seconds	5.18	2.77	20
60 seconds	4.25	2.66	20	60 seconds	3.95	3.26	20
65 seconds	3.96	2.79	20	65 seconds	3.28	3.20	20

Planned comparisons revealed that for both versions the difference between the 30s mean IP and 60s mean IP was statistically significant:  $F(1,19) = 32.16$ ,  $p <$

.01, partial  $\eta^2 = .63$ . However, the difference between the 60s mean IP and 65s mean IP was not statistically significant:  $F(1,19) = 4.23$ ,  $p = .05$ , partial  $\eta^2 = .18$ . To determine differences between delays in each of the two versions, separate planned comparisons were carried out. For the DAA the difference between the 30s mean IP and 60s mean IP was statistically significant:  $F(1,19) = 14.82$ ,  $p < .01$ , partial  $\eta^2 = .44$ ; and the difference between the 60s mean IP and the 65s mean IP was statistically significant:  $F(1,19) = 7.31$ ,  $p = .01$ , partial  $\eta^2 = .28$ . For the DAA (R) the difference between the 30s mean IP and 60s mean IP was statistically significant:  $F(1,19) = 26.97$ ,  $p < .01$ , partial  $\eta^2 = .59$ ; however the difference between the 60s mean IP and 65s mean IP in the DAA (R) was not statistically significant:  $F(1,19) = .46$ ,  $p = .51$ , partial  $\eta^2 = .02$ .

Figure 3.3 shows that mean IP decreased as delay to the LL reward increased. Although mean IPs were similar across the two CCT versions, IPs in the DAA (R) were consistently slightly larger than mean IPs in the DAA, however this difference was not statistically significant (as shown for Version in Table 3.1).

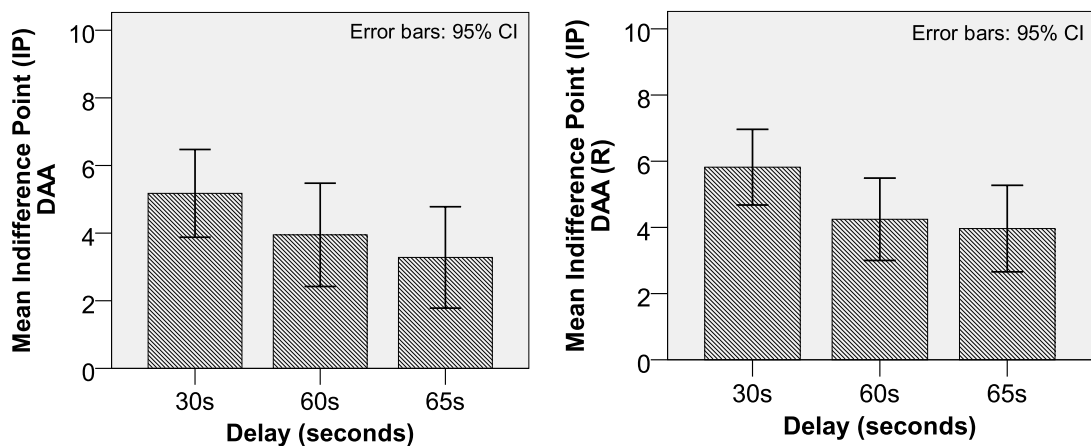


Figure 3.3 Mean indifference points (IPs) and associated error bars across the 30, 60 and 65 second delays for both versions of the CCT.



As can be seen in Figure 3.4 below, both true and rounded (see section 3.3.3) indifference curves obtained using the DAA (R) were similar to those obtained using the original DAA version for most participants. A few participants (such as P2, P3, P9, P11 and P16) produced slightly different discount curves for each version of choice task (CT). As illustrated in Figure 3.4, Participants 12 and 18 produced curves typically observed in delay discounting research, whereby their rate of discounting increased as the delay to the LL reward increased. A number of less typical discounting curves were produced, such as the sudden increase in IP from the 60s to the 65s delay conditions in the DAA (R) by P7 and P14. In addition, P13 made a corner solution, maximising rewards by choosing all 10p LL rewards at each of the three main delays (Figure 3.4).

Although individual differences in discounting rates were evident, typical discounting curves were obtained from approximately 70 percent of participants, the exceptions being P1, P2, P3 and P13 who maintained stable patterns of IPs across the delays, and P7, P9 and P14, who increased IP in the DAA (R) at the 65s delay. Therefore, it appeared that the novel behavioural task (CCT) measured delay discounting and was sensitive to individual differences in delay tolerance. As illustrated in Figure 3.4, the true and rounded indifference points from the DAA (R) were virtually identical throughout. The true value in the DAA (R) was the original value from which the rounded value was derived and therefore the most precise IP obtained. Consequently, analysis was carried out on IPs from the DAA (R) (true) rather than the rounded IPs.

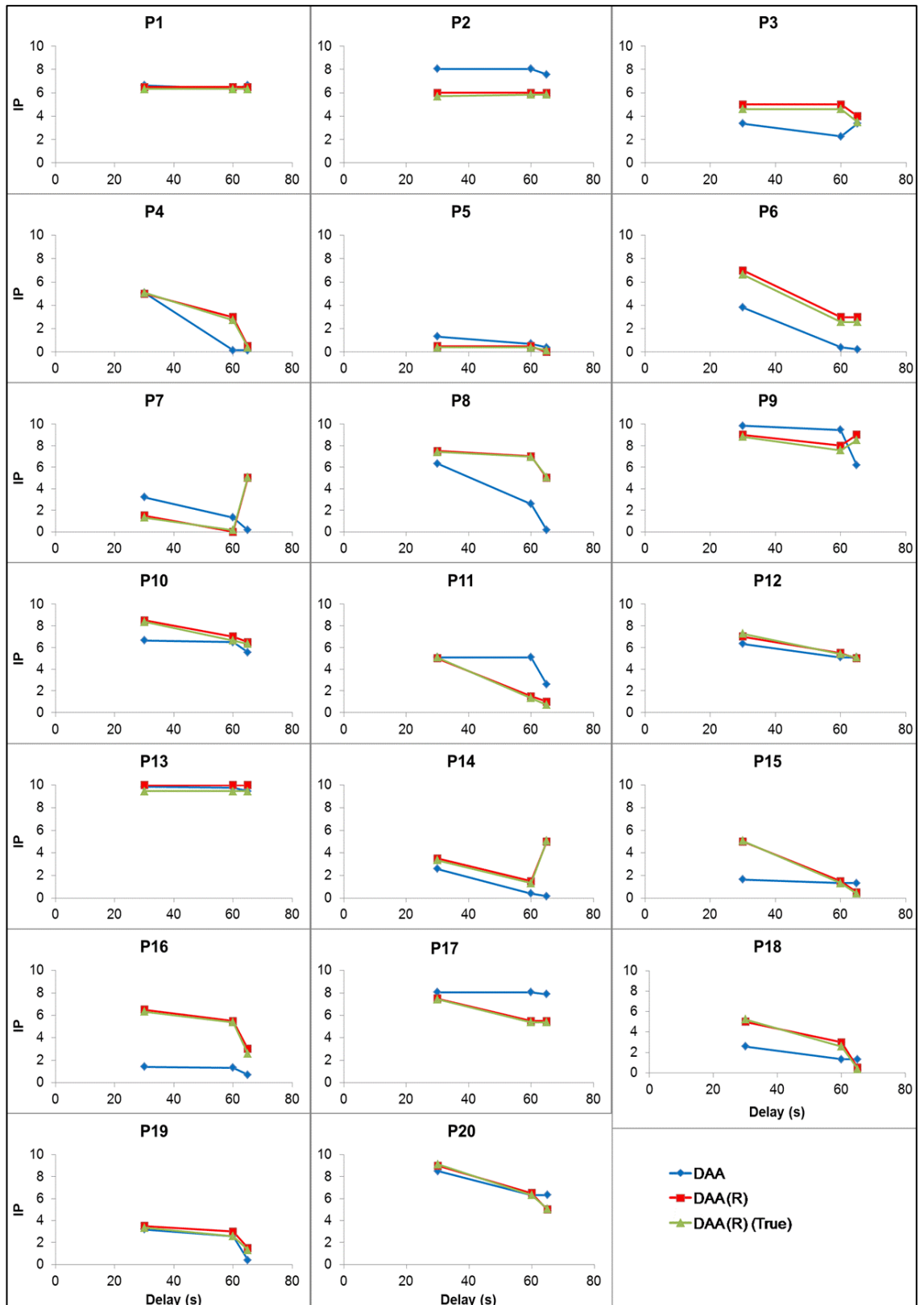


Figure 3.4 Indifference points (IP) obtained from each participant in both versions of the CCT adjustment algorithms.

It was possible that differences between the indifference curves displayed in Figure 3.4 could have been due to effects of the condition order. Given the significant non-normality of IP data at two delays (60s and 65s in the DAA), it was considered that a non-parametric test of difference would be most appropriate. Largest IPs were produced in the DAA (R) when it was presented to participants as the first CCT version ( $Mdn = 5.29$ ). Similarly, largest IPs were produced in the DAA when participants received it first ( $Mdn = 3.62$ ). A Mann-Whitney U test revealed a small effect of condition order on mean IPs obtained in the DAA, but the difference between participants who received the DAA followed by the DAA (R), and participants who received the DAA (R) followed by the DAA was not statistically significant:  $U = 41$ ,  $p = .53$ ,  $r = .15$ . Similarly, the Mann-Whitney U test revealed a small effect of condition order on mean IPs obtained in the DAA (R), but again the difference between participants who received the DAA followed by the DAA (R), and participants who received the DAA (R) followed by the DAA was not statistically significant ( $U = 38$ ,  $p = .39$ ,  $r = .2$ ).

Mean RT, mean RTSS and mean RTLL were calculated for each participant (again, practice RT data were not included in analysis). Mean RTs for SS and LL choices in each version are displayed in Table 3.3. These data indicate that participants responded slightly faster towards SS rewards and slower towards LL rewards in both versions.

Table 3.3 *Details of mean RTSS and mean RTLL, associated standard deviations (SD) and the total number of trials from which mean values were derived for both CCT versions.*

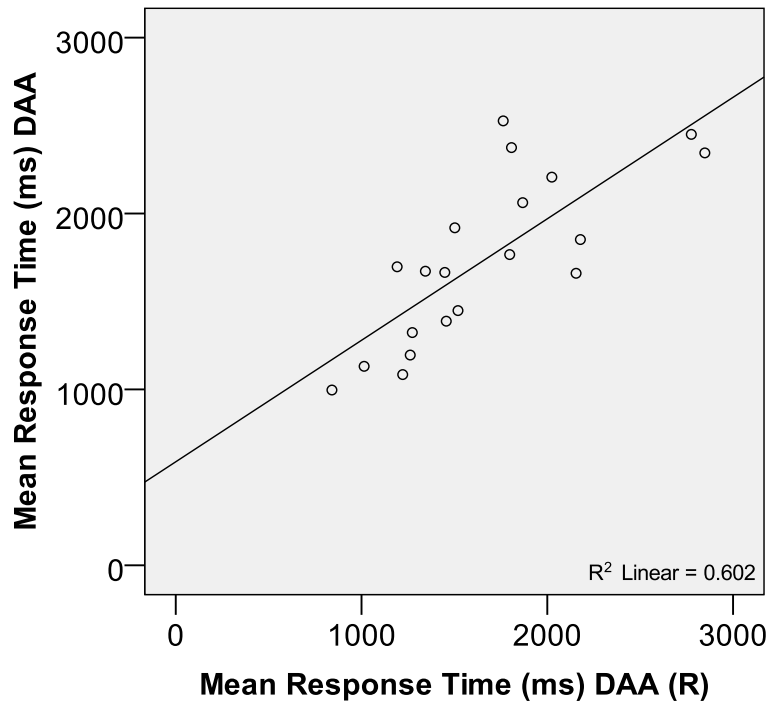
Version	Reward	<i>n</i>	Trials	Mean RT	SD
DAA	RTSS	20	238	1701.74	558.3
	RTLL	20	122	1827.74	692.6
DAA (R)	RTSS	20	235	1569.05	494.3
	RTLL	20	125	1765.88	696.2

Tests for normality (Shapiro-Wilk and histogram distributions) showed RTSS (response time for more immediate reward choices) and RTLL (response time for delayed reward choices) in both the DAA and in the DAA (R) to be deviated significantly from a normal distribution. Therefore, RT data were analysed using non-parametric tests. According to a Wilcoxon signed ranks test, the difference between RTSS (*Mdn* = 1512.6) and RTLL (*Mdn* = 1766.3) in the DAA was small and not statistically significant:  $z = -.78$ ,  $p = .43$ ,  $r = .18$ . The Wilcoxon signed ranks test revealed a medium effect size, but no statistically significant difference between RTSS (*Mdn* = 1374.1) and RTLL (*Mdn* = 1662.2) in the DAA (R):  $z = -1.53$ ,  $p = .13$ ,  $r = .34$ .

Since condition order was counterbalanced between participants, it was possible that it had an effect on RT. Larger RTs were produced in the DAA when participants received it first (*Mdn* = 1807.9) and larger RTs were produced in the DAA (R) when participants received it first (*Mdn* = 1658.5). However, a Mann-Whitney U test revealed a small and not statistically significant difference in the DAA between participants who received the DAA followed by the DAA (R)

( $n = 10$ ) and participants who received DAA (R) followed by the DAA ( $n = 10$ ):  $U = 44$ ,  $p = .68$ ,  $r = .10$ . In addition, the Mann-Whitney U test showed a medium and not statistically significant difference in the DAA (R) between participants who received the DAA followed by the DAA (R) ( $n = 10$ ) and participants who received DAA (R) followed by the DAA ( $n = 10$ ):  $U = 31$ ,  $p = .17$ ,  $r = .32$ .

Although unsurprising, but confirming similarities between versions, response times (RTs) correlated significantly between delays within each CCT version. Furthermore, response times between the three main delays (30s, 60s and 65s) in the DAA (R) and the DAA were significantly correlated. Figure 3.5 shows that as mean RT increased in the DAA (R), mean RT similarly increased in the DAA. A Spearman's rho correlation revealed this relationship to be significant:  $r_s = .78$ ,  $p < .01$ ,  $n = 20$ . This suggests consistency between the two versions, as participants responding quickly in one version similarly responded quickly in the other version.



*Figure 3.5* Correlation between mean response times (ms) taken from the three main delays (30s, 60s, 65s) for each CCT version.

Given the non-normality of some of the IP and RT data, correlations exploring relations between these data and with the self-report measures were carried out using Spearman's rho. The Spearman's rho correlation between RT and IP at the 65s delay in the DAA was significant (Table 3.4), but correlations between RT and IP at all other delays were not significant. Spearman's rho correlation between mean IP and mean RT in the DAA was statistically significant, but the correlation between mean IP and mean RT in the DAA (R) was not statistically significant (Table 3.4).

Table 3.4 Spearman's rho ( $r_s$ ) correlations between mean response time (RT) and mean indifference point (IP) data for both versions of the CCT (DAA and DAA (R)).

Measure 1	Measure 2	$r_s$	$p$	$n$
Mean IP (65s) DAA	Mean RT (65s) DAA	.47	.04*	20
Mean IP DAA	Mean RT DAA	.47	.04*	20
Mean IP DAA (R)	Mean RT DAA (R)	.41	.08	20

Note: \*Spearman's rho correlation is significant at the  $p < .05$  level.

The CAMM was scored out of 100 and the Junior I.6 was scored out of 23. To simplify data analysis, scores from the Junior I.6 were calculated as a percentage. Normality tests (Shapiro-Wilk and histogram distributions) revealed Junior I.6 and CAMM to be normally distributed. A Pearson's Correlational analysis found no significant correlation between the Junior I.6 and the CAMM ( $r = -.19$ ,  $p = .42$ ,  $n = 20$ ). Furthermore, Spearman's rho revealed no significant correlations between mean IPs and RTs with either the CAMM or Junior I.6 (Table 3.5).

Table 3.5 Spearman's rho ( $r_s$ ) correlations between mean scores on the self-report measures (percentage), mean response time (RT) and mean indifference point (IP) data for both versions of the CCT (DAA and DAA (R)).

Measure 1	Measure 2	$r_s$	$p$	$n$
Junior I.6	Mean IP DAA (R)	-.08	.75	20
Junior I.6	Mean IP DAA	-.08	.73	20
Junior I.6	Mean RT DAA (R)	-.14	.56	20
Junior I.6	Mean RT DAA	-.06	.8	20
CAMM	Mean IP DAA (R)	.13	.59	20
CAMM	Mean IP DAA	-.07	.76	20
CAMM	Mean RT DAA (R)	-.06	.8	20
CAMM	Mean RT DAA	-.05	.82	20

To summarise, results from both versions of the CCT indicated individual differences in discounting rates between participants. Seventy percent of participants produced discounting behaviour typical of previous delay discounting research, as their rate of discounting increased as the delay to the larger reward was increased. This was confirmed through finding a main effect of delay and significant differences between IPs at different delays. Both the DAA (R) and the DAA obtained similar response patterns and, although similar discounting was found between the two CCT versions, there was no evidence of a significant effect of order on IPs or on RT data. Furthermore, RTs in one version were correlated with RTs on the other version, but there was no significant difference between RTSS and RTLL in either version of the CCT. No significant correlations were found between IP and RT at each delay, CAMM and Junior I.6 scores, and between self-reports and IPs or RTs.



### **3.5 Discussion**

Confirming the original prediction and further supporting previous research in delay discounting, this indicated that as the delay increased, participants increased their responding to the more immediate reward. In other words, participants discounted more rapidly as the delays increased. Indifference points for each participant across delays were similar for each of the two versions of the task. Additionally, the rounded indifference points for the DAA (R) (taken from the reward amounts presented on the screen to participants) were virtually identical to the true indifference points for the DAA (R) (taken from the reward value that would have been presented in the original DAA version). This was further supported by the relatively large correlation between the modified DAA (R) and the original DAA version developed by Du et al. (2002), with no significant main effect of version found in the ANOVA.

In addition, the ANOVA revealed a statistically significant main effect of delay on IPs in the expected direction, suggesting that the choice task effectively measured delay discounting. Therefore, it seems reasonable to administer the DAA (R) to adolescents with BESD as a more suitable measure of delay discounting in adolescents with BESD, given the need to display rounded monetary rewards.

There was no evidence of significant correlations between the CCT, the Junior I.6 Scale and the CAMM. Such lack of consistency between behavioural and self-report measures has been frequently reported in previous research (e.g., Reynolds, Ortengren, Richards & De Wit, 2006). In the present study, it could

have occurred because both self-report measures were devised for children rather than university students.

Participants 1 and 13 maintained similar indifference points throughout the delays for both versions of the adjusting procedure, with P13 making a corner solution. This was likely to be because the delays used in this study were not long enough to generate discounting of rewards by these participants. However, this study provided evidence consistent with previous temporal discounting research (e.g., Myerson & Green, 1995; Rachlin & Green, 1972; Du, Green & Myerson, 2002). It appears that the novel computerised choice task (CCT) and modified version of Du et al.'s (2002) adjustment algorithm (the DAA (R)) is an effective behavioural measure of delay discounting in undergraduate university students.

Although not a significant difference, the results of Experiment 3 showed that participants chose more quickly when making choices towards immediate rewards and were slower at choosing the delayed rewards. This is contrary to the RT results obtained in Experiments 1 and 2, but is consistent with findings from Mitchell (1999) that participants respond faster when choosing impulsively and slower when making more self-controlled choices. As participants were presented with two slightly different versions of the same task, session duration may have affected IP, RT and self-report data. Consequently, a further study was necessary in which the DAA (R) would be administered alone, in addition to the self-report scales, to a larger population.

## **Experiment 4**

### **The DAA (R) and Relations Between Measures of Impulsivity and Mindfulness**

#### **3.6 Introduction**

The results of Experiment 3 suggested that delay discounting produced by participants in the DAA (R) was similar to that produced by participants in the original DAA developed by Du et al. (2002). Furthermore, it appeared that the computer choice task (CCT) was an effective measure of delay discounting in undergraduate psychology students, producing behaviour to support previous discounting research. However, given repeated testing of similar CCTs, there was a possible effect of session duration on participants' responding. Therefore, it was necessary to carry out a further study to explore results produced from the DAA (R) CCT only. These data could be compared to data obtained in Experiment 3, and session duration could be assessed in relation to concerns that a long session duration might affect participants' responding. Therefore, Experiment 4 was designed to determine whether the DAA (R) CCT was the most effective delay discounting measure and to explore relations between delay discounting, response times (RT) and scores on a self-report impulsivity scale (Junior I.6) and mindfulness measure (CAMM).

#### **3.7 Method**

##### **3.7.1 Participants**

Forty undergraduate psychology students (38 female and two male, aged between 18 and 41 years, with a mean age of 20 years and 10 months,  $SD = 4.1$ ) from the University of Plymouth (none of whom had previously participated

in Experiment 3) were recruited through a participation point system as part of their university course. Participants also received payment for participating according to rewards they chose in the CCT.

### **3.7.2 Materials**

Prior to commencement of the testing session, each participant was given a consent form to read and sign, the brief and an information sheet detailing the instructions (see Appendices J and K for details). A further handout containing the debrief and the experimenters contact details was given to participants at the end of the testing session (see Appendix L). The laptop, headphones, joystick and two transparent containers used previously in Experiments 1, 2 and 3 were used for the CCT (see section 2.2.2 for details). The experimenter recorded each participant's CCT scores and reward values at each delay on a data sheet that was similar to that used in Experiment 3 (see Appendix M). Following completion of the CCT participants were given a pen and the Junior I.6 Impulsivity sub-scale (Eysenck, Easting & Pearson, 1984) to complete followed by the CAMM (Child Acceptance and Mindfulness Measure, Greco & Baer, 2005).

### **3.7.3 Design and Procedure**

A within subjects design was used in which all participants were presented with the DAA (R) CCT, followed by the Junior I.6 and the CAMM. Participants were required to sign a consent form, given a brief, and then received the general instructions and instructions for the practice task (see section 2.2.3 for details of the computer choice task). Participants were permitted to ask questions during the practice and on completion, the experimenter asked if they had any

questions and were happy to continue. Participants then received the instructions for the main task in which they were presented with six choices at three delays (presented in ascending order), followed by the two questionnaires.

The delayed amount remained fixed at 10p throughout the task, and the immediate value was adjusted according to the modified DAA (R) outlined in Experiment 3 (see section 3.3.3 for full details). As noted in Experiment 3, during the testing session for Participant number 10 in Experiment 4 the experimenter noticed the final delay appeared to be of a similar duration to the third (60 seconds) delay. This final delay was timed and averaged across a total of ten time trials was approximately 65 seconds rather than the intended 90 seconds. Therefore, the first ten participants received delays of 15, 30, 60 and 65 seconds. The CCT was reprogrammed and the final thirty participants received the originally intended delays of 15 (practice), 30, 60 and 90 seconds. Delays continued to be presented in ascending order to enable greater comparison between individuals' discounting behaviour. For reasons of analysis, the two sets of results are presented separately as Part I and Part II.

## **3.8 Results**

### **3.8.1 Results (Part I)**

Data were analysed for the first ten participants who received 15, 30, 60 and 65 second delay conditions. As for Experiment 3, the 15 second delay condition was removed from analysis of IP and RT data. Tests of normality (Shapiro-Wilk and histogram distributions) showed IP data to not significantly deviate from a normal distribution. A one-way within-participant ANOVA was performed on IP

data to determine whether there was a significant effect of delay on IP. Largest mean IPs were produced in the 30s delay condition and smallest mean IPs were produced in the 65s delay (Table 3.6). Results revealed a significant main effect of delay (Table 3.6).

Table 3.6 *Descriptive statistics for mean indifference points (IP) at each delay and results of a one-way ANOVA.*

Delay	Mean IP	SD	<i>n</i>	<i>df</i>	<i>F</i>	$\eta^2$	<i>p</i>
30s	7.09	2.34	10				
60s	5.94	2.91	10	2 (18)	7.56	.46	< .01
65s	4.79	3.68	10				

Planned comparisons (Table 3.7) revealed a medium size of effect and significant difference between the IPs obtained at 30s and 60s delay conditions, and a medium effect size, but not statistically significant difference between the IPs obtained at the 60s and 65s delays.

Table 3.7 *Planned comparison results obtained within the one-way ANOVA on the difference between mean IPs obtained at the different delays.*

Delay	Delay	<i>n</i>	<i>df</i>	<i>F</i>	$\eta^2$	<i>p</i>
30s	60s	10	1 (9)	6.38	.42	.03*
60s	65s	10	1 (9)	5.10	.36	.05

Note: \* Significant at the  $p < .05$  level

Results displayed in Table 3.6 and 3.7 suggest that delays differed significantly from one another in the expected direction, providing evidence in support of

previous discounting research. In Addition, this suggests that the CCT was an effective measure of delay discounting in the sample of ten undergraduate students.

Typical discounting behaviour was produced by 70 percent of participants, whereby the rate of discounting increased as the delay to the LL increased. Participants 7 and 9 presented ceiling effects, choosing the 10p reward option consistently throughout (see Figure 3.6), suggesting the possible need to increase delays for these individuals in order to effectively bracket their discounting behaviour.

Uncharacteristically for discounting research, P8 slightly increased the number of choices made towards LL rewards as the delay to it increased. After the testing session a number of participants reported that they were uncertain of whether they would genuinely receive their rewards. It is possible therefore that P8 produced more self-controlled responding having observed the monetary reward increase with each choice made in the three main delays. As is evident from Figure 3.6, several participants appeared to produce relatively high indifference points across the delays (e.g., P3, P7 and P9), discounting rewards at a relatively low and stable rate throughout. However, a number of participants discounted at a higher rate (e.g., P2 and P5), discounting the larger delayed reward as the delay increased more quickly. This finding emphasised the large variation between individual participants with respect to the size of delay and relative reward value.

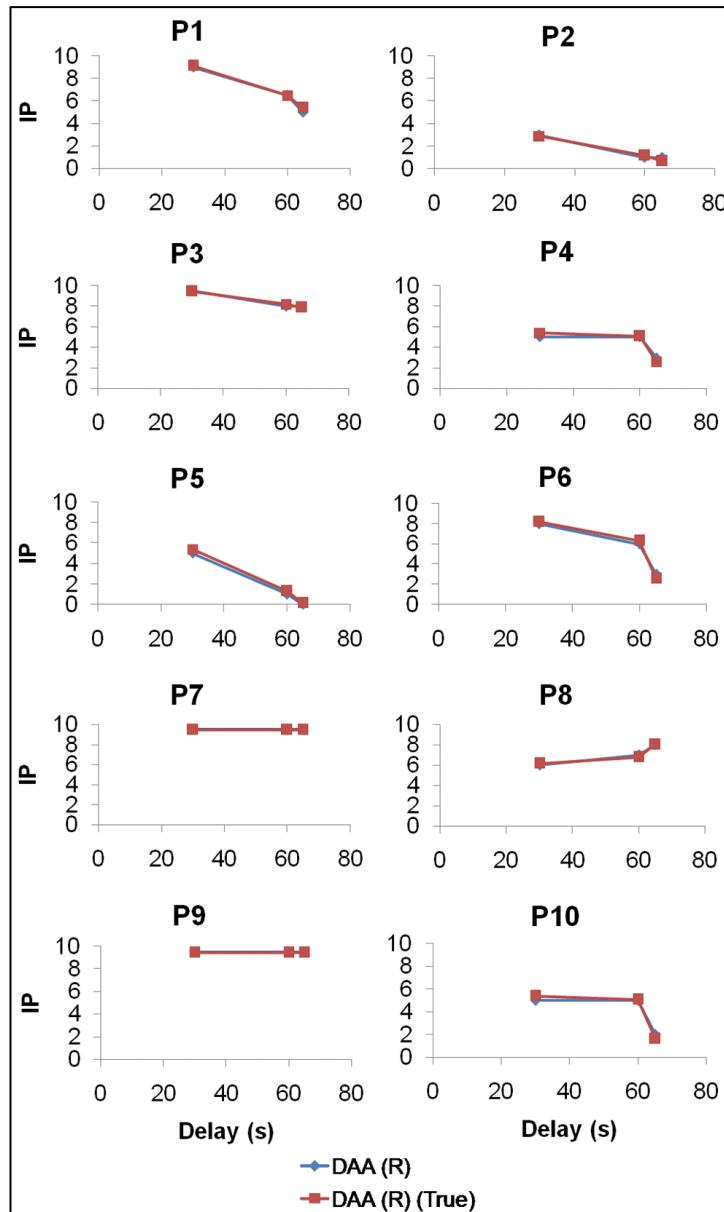


Figure 3.6 Indifference points for each participant in Experiment 4 across all delays.

To determine whether RTSS was smaller than RTLL mean RTs were calculated for SS (RTSS) and LL (RTLL) choices across the three main delays. However, as shown in Table 3.8, mean RTSS and mean RTLL were found to be similar. For RTLL the number of participants was 9 because data from one participant (P2) could not be calculated as only SS (more immediate) rewards were chosen.



Table 3.8 *Mean response times and associated standard deviations (SD) towards more immediate (RTSS) and delayed (RTLL) rewards and the number of trials from which the means were calculated.*

	Mean RT	SD	<i>n</i>	Trials
RTSS	2059	1043	10	103
RTLL	2096	530	9	77

Figure 3.7 shows RTSS was fastest at the 30 second delay. In the 60s delay condition participants generally responded more slowly when choosing more immediate rewards than delayed rewards, but in the 30s and 65s delay conditions participants responded faster when they chose the more immediate rewards and more slowly when choosing the larger more delayed rewards. Since participants chose either LL or SS rewards, the number of trials in which SS and LL had been chosen varied between delays. The mean RTs displayed in Figure 3.7 were calculated from 29 trials (30 RTSS), 36 trials (60 RTSS), 38 trials (65 RTSS), 31 trials (30 RTLL), 24 trials (60 RTLL), and 22 trials (65 RTLL).

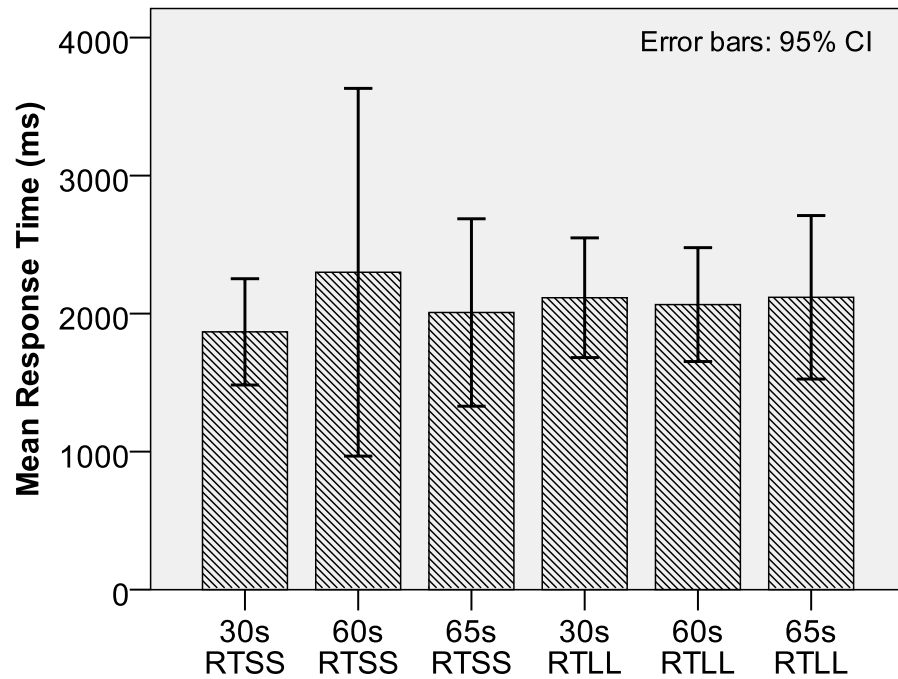


Figure 3.7 Mean Response Times (ms) and associated error bars for participants' responses to both delayed and immediate rewards in each delay condition.

Tests for normality (Shapiro-Wilk and histogram distributions) revealed significant deviations from normality for several of the RT data at different delays and for the CAMM scores. Therefore, correlations were analysed using Spearman's rho. Unsurprisingly, and suggesting consistency in participants responding between delays, there were significant positive correlations between RTs obtained at different delays. There were no statistically significant correlations between IP and RT at each delay (Table 3.9). Correlations between IP and the two self-report scales were not statistically significant and correlations between RT and the CAMM and Junior I.6 were not significant. Additionally, there was no statistically significant correlation between the Junior I.6 and the CAMM (Table 3.9).

Table 3.9 Spearman's ( $r_s$ ) correlations between response times (RT), indifference points (IP), Junior 1.6 and the CAMM.

Measure 1	Measure 2	$r_s$	$p$	$n$
30 IP	30 RT	.34	.33	10
60 IP	60 RT	.38	.27	10
65 IP	65 RT	.57	.09	10
Mean IP	Junior 1.6	-.29	.42	10
Mean IP	CAMM	.12	.74	10
Mean RT	Junior 1.6	-.22	.54	10
Mean RT	CAMM	.27	.44	10
Junior 1.6	CAMM	-.43	.21	10

### 3.8.2 Results (Part II)

Following reprogramming the CCT to deliver the intended delays correctly, a further 30 participants received CCT delays of 15s (practice), 30s, 60s and 90s. Figure 3.8 shows a typical pattern of discounting where mean IP decreased as the delay to the more delayed reward (LL) increased (with the practice data removed).

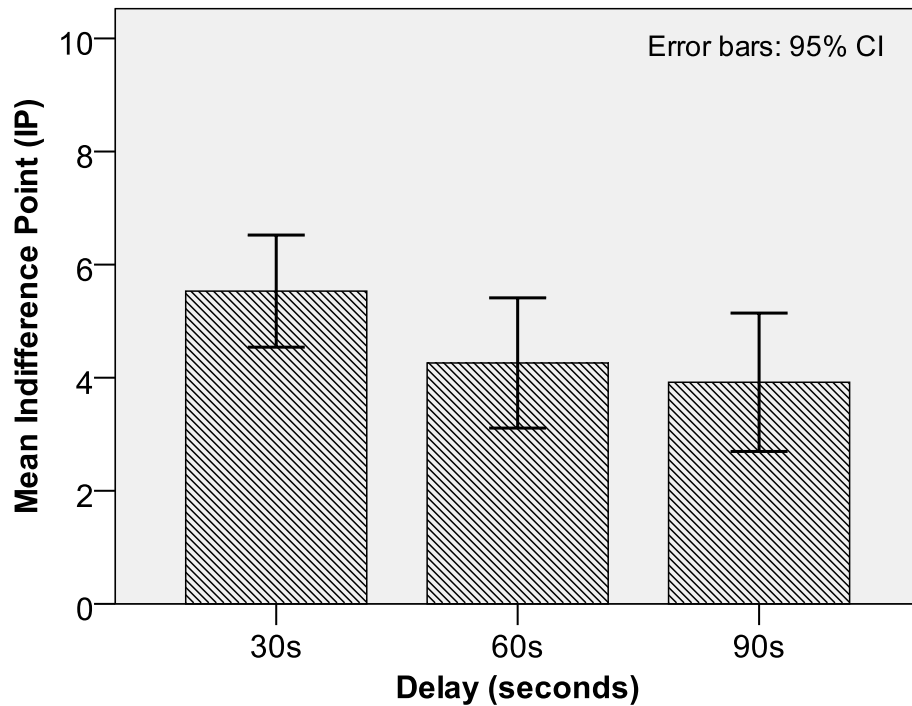


Figure 3.8 Mean indifference points (IP) and associated error bars produced by participants in Experiment 4 (Part II) for each of the three main delays ( $n = 30$  for each delay).

Tests for normality (Shapiro-Wilk) revealed that mean IP at the 60s delay ( $D(30) = 0.92, p = .03$ ) and at the 90s delay ( $D(30) = 0.87, p < .01$ ) were both distributed significantly differently from normal. As a result, to determine whether delay effected IPs a Friedman one-way within-subjects test was performed on IP data. This showed that IPs varied significantly across the 3 delays:  $\chi^2(2, n = 30) = 12.93, p < .01$ . Wilcoxon tests were used to follow up this significant effect and a Bonferroni correction was applied, therefore effects are reported at a .0167 significance level. Indifference points (IPs) were significantly different between the 30s ( $Mdn = 5.39$ ) and 60s ( $Mdn = 3.28$ ) delays ( $z = -3.23, p < .01, r = -.42$ ) and between the 30s and 90s ( $Mdn = 2.58$ ) delays ( $z = -3.08, p$

$< .01$ ,  $r = -.4$ ). However, there was no statistically significant difference between IPs produced the 60s and 90s delays ( $z = -.37$ ,  $p = .71$ ,  $r = -.05$ ).

Figure 3.9 shows the discount curves produced from each participant's IP obtained at each delay using the DAA (R) version of the CCT. As can be seen from Figure 3.9 participants varied greatly in their tolerance of delays. Participants such as P11 and P12 chose the smaller sooner reward (more impulsive response) most frequently. On the other hand, P18 and P30 for example, presented high toleration of the delays, frequently choosing the larger delayed reward option (a more self-controlled response). A ceiling effect occurred with IP data for P26, suggesting that the delays were too short for this individual to discount the larger reward. On the other hand, a floor effect occurred with P23 indicating that either the delays were too large or the reward was too small for this individual to choose the larger delayed reward. Figure 3.9 shows that approximately 50 percent of participants produced IPs less than 5 for all delays suggesting relatively high impulsive responding. The remaining 50 percent of participants produced IPs of more than 5 for each delay condition indicating more self-controlled responding.

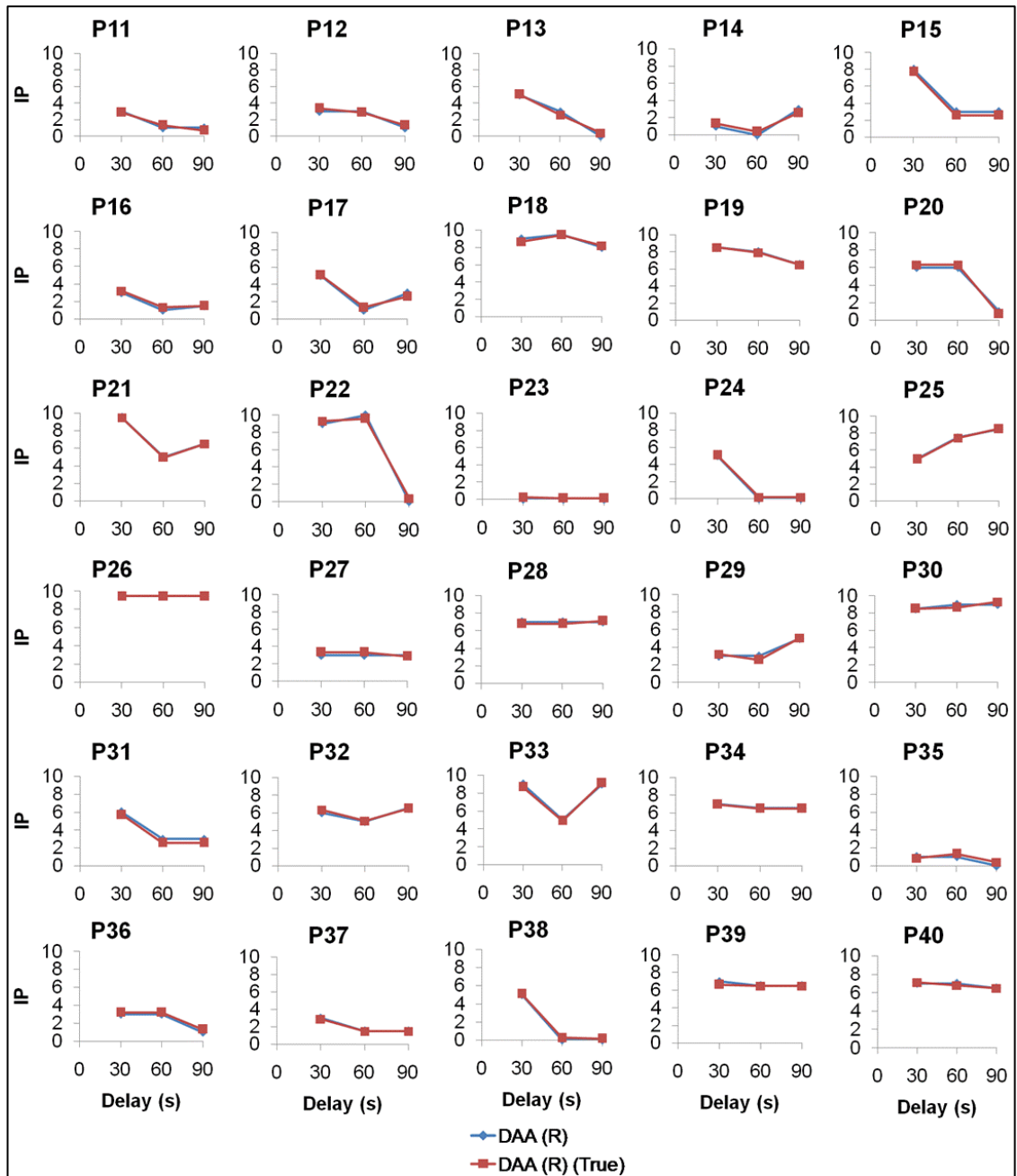


Figure 3.9 Discount curves for indifference points (IP) obtained at each delay for each participant ( $n = 30$ ).

Disregarding the 15s data point in Figure 3.9, approximately 60 percent of participants (for example, participants 11, 12, 13, 15, 19 and 37) produced typical discounting, whereby participants increased the rate at which they discounted the larger reward as the delay to it increased. In particular,

participants 15, 20, 22, 24 and 38 showed steep indifference curves. A number of participants (for example, participants 18, 26 and 30) maintained relatively high and stable indifference points across delays (Figure 3.9). Participants 14, 15, 17, 21, 25, 32 and 33 for example, either maintained their indifference point across 60s and 90s delays, or actually increased self-controlled responses (choices toward the larger delayed reward) at the final 90s delay.

Mean RTs (ms) aggregated across the three main delays were similar for more immediate reward (RTSS) choices ( $M = 1740$ ,  $SD = 760$ ,  $n = 30$ ) and more self-controlled choices (RTLL) towards the larger delayed rewards ( $M = 1723$ ,  $SD = 709$ ,  $n = 30$ ). Mean RTs were similar between the 30s and 60s delays, but RTSS at 90s was smaller than RTLL at 90s (Figure 3.10). Tests for normality revealed that RT data at most delays and mean RT data deviated significantly from a normal distribution (in Shapiro-Wilk normality tests and histogram distributions were skewed).

A Wilcoxon signed ranks test revealed no statistically significant difference between the RTSS ( $Mdn = 1533$ ) and RTLL ( $Mdn = 1544.88$ ) at the 30s delay ( $z = -0.98$ ,  $p = .33$ ,  $r = -.13$ ), between the RTSS ( $Mdn = 1544.42$ ) and RTLL ( $Mdn = 1354$ ) at the 60s delay ( $z = -1.62$ ,  $p = .11$ ,  $r = -.21$ ) and between RTSS ( $Mdn = 1335$ ) and RTLL ( $Mdn = 1524.67$ ) at the 90s delay ( $z = -0.26$ ,  $p = .79$ ,  $r = -.03$ ). Since participants made either SS or LL choices, the number of trials from which each mean RT value (Figure 3.10) was obtained differed between delays: 97 (30 RTSS), 108 (60 RTSS), 120 (90 RTSS), 83 (30 RTLL), 72 (60 RTLL), 60 (90 RTLL).

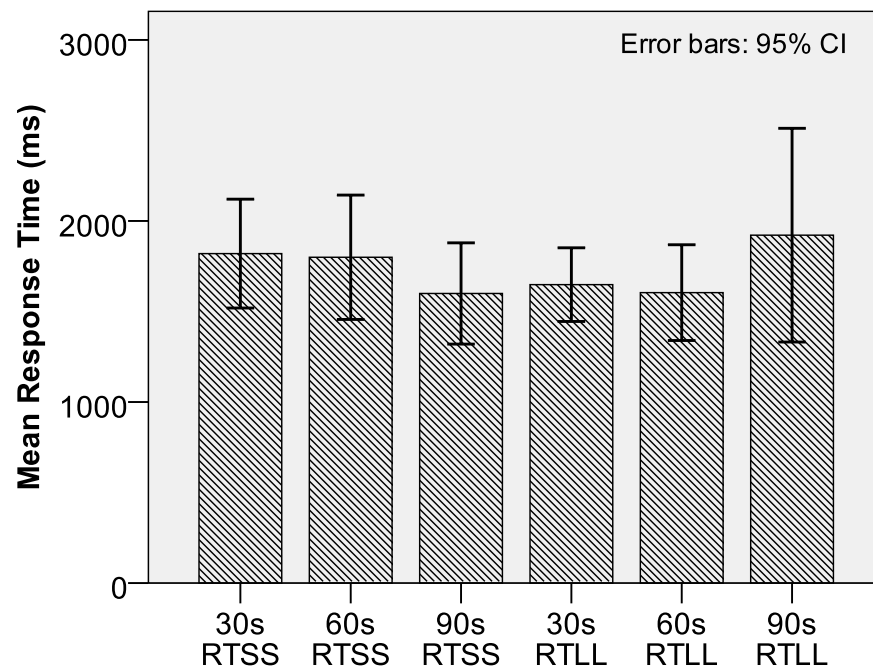


Figure 3.10 Mean response times towards more immediate (RTSS) and delayed (RTLL) at each delay ( $n = 30$  for all except 60s RTLL ( $n = 28$ ) and 90s RTLL ( $n = 27$ )).

Data were analysed for correlations between each participant's indifference points (IPs), scores from self-report scales and reaction times (RT) for responses to immediate and delayed rewards in this study for 30, 60 and 90 second (s) delays ( $n = 30$ ). Further tests for normality (Shapiro-Wilk and histogram distributions) revealed that in addition to IP and RT data, self-report scores were also significantly deviated from normality (Junior I.6:  $D(30) = .93$ ,  $p = .04$ ). Therefore, correlations were analysed using Spearman's rho and are displayed in Table 3.10 below.

Although unsurprising perhaps, RTs between delays were significantly correlated suggesting that each participant's RTs were similar across the different delays. This was supported by a Friedman's test which found no effect



of delay on RT:  $\chi^2(2, n = 30) = 1.4, p = .5$ . At the 60s delay IP was significantly correlated with RT, but correlations between IP and RT at other delays were not significant (Table 3.10). The relationship between the Junior I.6 and the CAMM was negative (as anticipated), but not significant ( $r_s = -.35, p = .06, n = 30$ ), and there were no significant correlations between the two self-report scales administered and other measures (Table 3.10).

Table 3.10 Spearman's ( $r_s$ ) correlations between response times (RT), indifference points (IP), Junior I.6 and the CAMM.

Measure 1	Measure 2	$r_s$	$p$	$n$
30 IP	30 RT	.03	.88	30
60 IP	60 RT	.46	.01*	30
65 IP	65 RT	.13	.48	30
Mean IP	Junior 1.6	.21	.26	30
Mean IP	CAMM	-.05	.78	30
Mean RT	Junior 1.6	.22	.25	30
Mean RT	CAMM	-.22	.25	30
Junior I.6	CAMM	-.35	.06	30

Note: \*Correlation is significant at the  $p < .05$  level (two-tailed).

### 3.8.3 Combined results for Experiment 4 (Part I and Part II)

All practice data were removed for analysis. Therefore, Figure 3.11 shows mean IPs obtained for the 30s ( $n = 40$ ), 60s ( $n = 40$ ), 65s ( $n = 10$ ) and 90s ( $n = 30$ ) delays by participants in Experiment 4. Mean IPs decreased between the 30s and 60s delays and between the 60s and 90s delays, but increased very slightly between the 60s and 65s delays. Given the small difference of 5

seconds between the 60s and 65s delays, it was likely that mean IPs would have been similar. Therefore, across the ascending delay conditions, Figure 3.11 shows that the CCT produced results consistent with traditional measures of delay discounting.

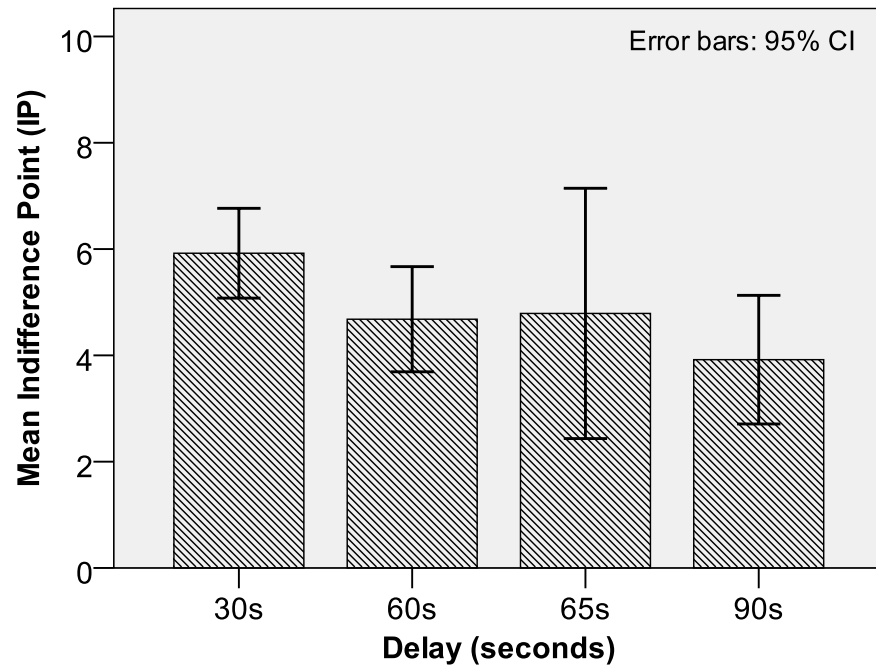


Figure 3.11 Mean Indifference Points (IP) and associated error bars obtained by participants in each delay condition (excluding all practice data) in Experiment 4 (Parts I and II).

Tests of normality revealed that for IPs three of the four delays were significantly deviated from the normal distribution: 30s ( $D(40) = .94, p = .04$ ), 60s ( $D(40) = .92, p = .01$ ) and 90s ( $D(30) = .87, p < .01$ ). Therefore to determine whether differences between IPs at different delays were significant, a Wilcoxon signed ranks test was performed and a Bonferroni correction was applied (therefore effects are reported at a .01 significance level). Table 3.11 shows a

statistically significant difference between the 30s and 60s delays and between the 30s and 90s delays.

Table 3.11 *Results of the Wilcoxon signed ranks test and effect sizes (r) for comparisons between indifference points (IP) at the main delays.*

Delay 1	Delay 2	<i>n</i>	<i>T</i>	<i>z</i>	<i>p</i>	<i>r</i>
30s	60s	40	66.5	-3.83	<.01*	-.60
30s	65s	10	2	-2.24	.03	-.97
30s	90s	30	75	-3.08	<.01*	-.56
60s	65s	10	5	-1.82	.07	-.58
90s	60s	30	115	-.374	.71	-.07

Note: \*Significant at the  $p < .01$  level (two-tailed).

Figure 3.12 shows that participants had largest mean RTs at the 65s delay ( $M = 2961\text{ms}$ ,  $SD = 1184$ ,  $n = 10$ ), with smallest mean RTSS at the 90s ( $M = 1600\text{ms}$ ,  $SD = 749$ ,  $n = 30$ ) delay. Similar mean RTs were found between responses towards delayed (RTLL) rewards ( $M = 1816\text{ms}$ ,  $SD = 682$ ,  $n = 40$ ) and more immediate (RTSS) rewards ( $M = 1819\text{ms}$ ,  $SD = 837$ ,  $n = 40$ ). Mean RTSS and mean RTLL were similar at the 30s, 60s, and 65s delays. However, mean RTSS at 90s was smaller ( $M = 1600\text{ms}$ ,  $SD = 749$ ,  $n = 30$ ) than mean RTLL at 90s ( $M = 1921\text{ms}$ ,  $SD = 1500$ ,  $n = 27$ ). Further tests of normality (Shapiro-Wilk and histogram distributions) for RT data revealed that RT at several delays and mean RT were significantly positively skewed. Therefore, to determine whether any difference between RTSS and RTLL was significant a Wilcoxon signed ranks test was carried out. However, it revealed no statistically significant differences between RTSS and RTLL at each delay.

It is important to note that since participants chose SS and LL rewards, the number of trials from which mean RTLL and mean RTSS were obtained vary. Specifically, the number of trials for RTSS and RTLL at each delay (Figure 3.12) were: 97 (30 RTSS), 83 (30 RTLL), 108 (60 RTSS), 72 (60 RTLL), 38 (65 RTSS), 22 (65 RTLL), 120 (90 RTSS) and 60 (90 RTLL). Therefore, overall the total number of trials from which mean RTSS (across all main delays) was calculated was 325 and the total number of trials from which mean RTLL (across all main delays) was calculated was 215.

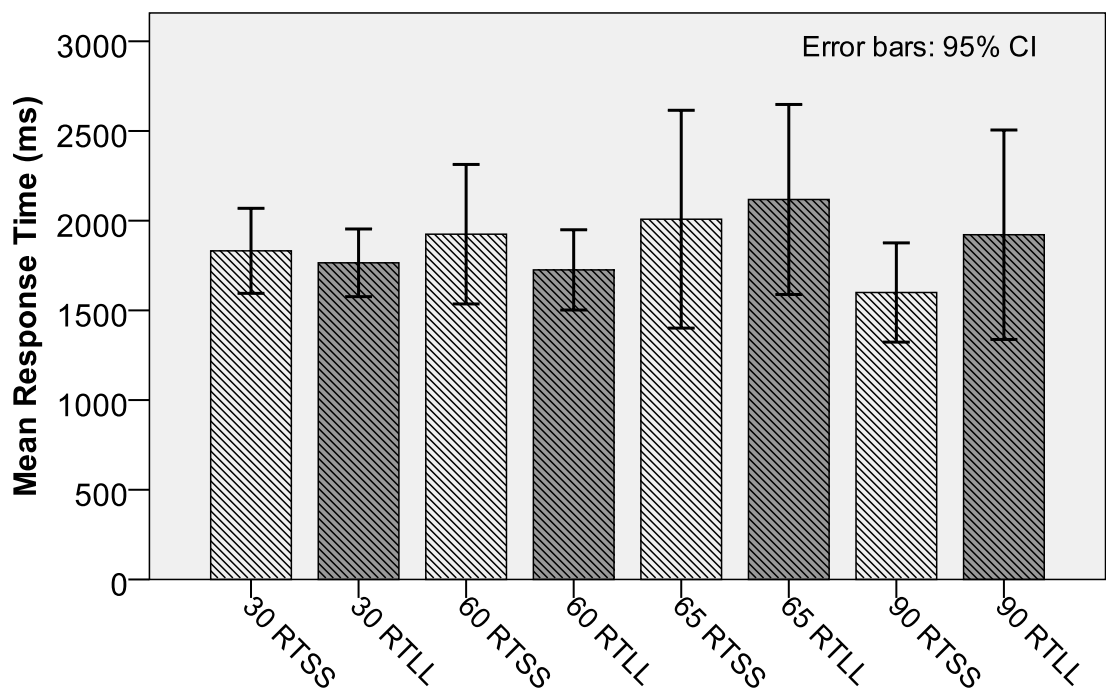


Figure 3.12 Mean response times (ms) and associated error bars produced by participants in Experiment 4 for the main delays.

In addition to IP and RT data, analysis using the Shapiro-Wilk normality test and inspection of distributions of data showed that the self-reports were significantly deviated from a normal distribution. As a result, Spearman's rho was performed

to explore correlations between CCT data, response times (RT), and self-report measures. To compare general discounting behaviour with other measures, mean IP (excluding the 15s practice delay) was calculated for each participant. However, due to the likely skew of such data (as reported by Myerson, Green & Warusawitharana, 2001), the area under the curve was also calculated for each participant to provide an additional measure of participants' discounting (see section 1.4.2 of the current thesis).

Mean IPs at each delay were significantly correlated with mean IPs at other delays and mean RTs at each of the main delays were also significantly correlated with mean RTs at other delays. Although perhaps unsurprising, this suggests consistency in discounting across delays (i.e., a participant making more self-controlled choices at one delay similarly made more self-controlled choices at other delays) and consistency in RT across delays (i.e., a participant responding more quickly in one delay responded similarly quickly at other delays). This lends confidence to the reliability of the general method.

Correlations between mean IPs and mean RTs at each delay were found to be only significant at the 60s delay (Table 3.12). However, Spearman's rho correlations (Table 3.12) revealed that mean RT was significantly correlated with both mean IP and area under the indifference curve. Therefore, participants with large area under the curve and large mean IPs (showing that they chose less impulsively) took longer to make choices.

Table 3.12 Spearman's ( $r_s$ ) correlations between response times (RT), indifference points (IP), Area under the curve (AuC), Junior I.6 and CMM. Mean RTs and IPs include those for individual delays and across all delays (30, 60, 65, 90).

Measure 1	Measure 2	$r_s$	$p$	$n$
Mean 30 IP	Mean 30 RT	.24	.14	40
Mean 60 IP	Mean 60 RT	.49	<.01**	40
Mean 65 IP	Mean 65 RT	.57	.09	10
Mean 90 IP	Mean 90 RT	.13	.48	30
Mean IP (30,60,65,90)	Mean RT (30,60,65,90)	.34	.03*	40
Mean IP (30,60,65,90)	Junior 1.6	.09	.57	40
Mean IP (30,60,65,90)	CMM	.07	.69	40
Mean RT (30,60,65,90)	Junior 1.6	.12	.48	40
Mean RT (30,60,65,90)	CMM	-.1	.55	40
Mean RT (30,60,65,90)	AuC	.39	.01*	40
CMM	AuC	.02	.92	40
Junior I.6	AuC	.08	.62	40
Junior I.6	CMM	-.35	.03*	40

Note: \*Correlation is significant at the  $p < .01$  level (two-tailed). \*\*Correlation is significant at the  $p < .05$  level (two-tailed).

Although most participants scored between 40 and 60 percent on the CMM, which suggests the coefficient was affected by the problem of restricted range (see Figure 3.13), a moderate but statistically significant negative correlation was found between the Junior 1.6 and the CMM (Table 3.12). The Junior I.6 did not correlate significantly with any of the other measures and no significant

correlations were found between mean IP, area under the curve, and mean RT with the CAMM or Junior I.6 (Table 3.12).

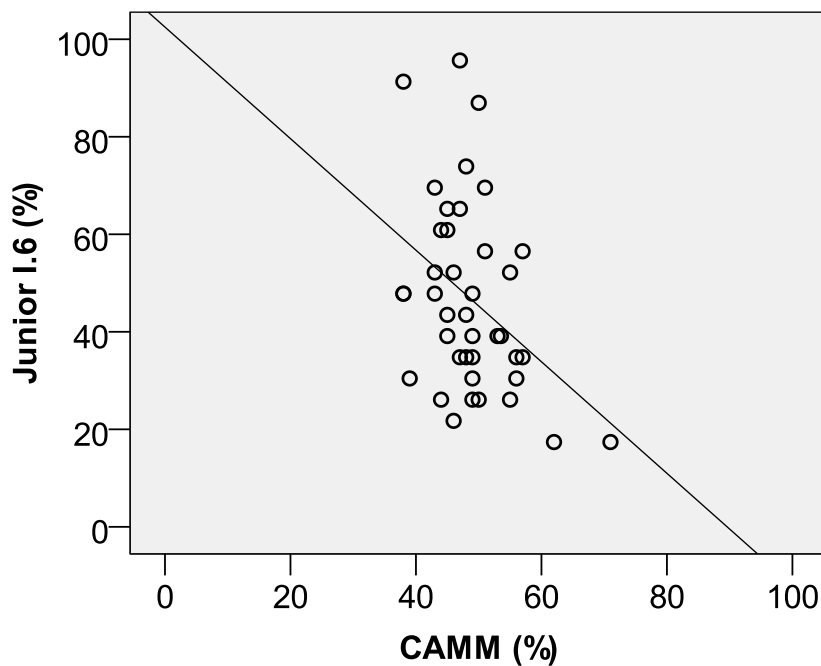


Figure 3.13 Scatter plot of percentage (%) scores obtained by participants on the Junior I.6 Impulsivity scale and scores obtained on the CAMM ( $n = 40$ ).

In summary, data from Experiment 4 suggest that although variability between participants' rates of delay discounting was high, on average participants increased their rate of discounting as the delay to the larger reward increased. Furthermore, participants who had higher IPs and a larger area under the curve (hence made less impulsive choices) generally took more time to respond, and there was a negative correlation between the Junior I.6 and the CAMM.

### 3.9 Discussion

Results from Experiment 4 showed large variability between individual's rates at which they discounted the delayed reward in the CCT, as expected. However, mean data produced in the CCT was generally typical of delay discounting

tasks, whereby participants discounted the larger reward more rapidly as the delay to it was increased. Therefore, the CCT designed in the present research was effective as a measure of delay discounting in university students. Furthermore, it seems reasonable to argue that the DAA (R) was a successful modification of the original adjustment procedure (the DAA) developed by Du et al. (2002) in which small monetary rewards could be used in place of large hypothetical values. This was a characteristic considered important with regard to future application of the CCT to adolescents with BESD. The task appeared to have good internal consistency whereby IPs and RT at one delay tended to be correlated with those at a different delay.

Of the total 40 participants, four reached corner solutions: three ceiling effects (choosing all larger more delayed rewards) and one floor effect (choosing all more immediate rewards) occurred. Ceiling effects were likely to have occurred because delays to the larger reward were too short or the reward was too highly valued for them to discount it and choose the more immediate reward. On the other hand, floor effects were possibly because delays to the larger reward were too large or the reward was too small for the participant to want to tolerate a delay to receive it. Therefore, in future studies it may be necessary to provide a larger range of delays and reward amounts to prevent such effects arising and successfully bracket participants' discounting.

Participants were informed they would receive 4 sets of 6 choice trials which may have affected their responding as a number of them produced similar IPs throughout by responding consistently across delays. Additionally, one participant in Part I (section 3.8.1) and 7 participants in Part II (section 3.8.2)



decreased their rate of discounting in the final delay, possibly as they knew that they were nearing the end of the study and wanted to obtain more money before they finished. Presenting delays in ascending order appeared to produce order effects. However, due to the limited number of participants it was not possible to counterbalance random orders effectively. In addition, as we were not interested in the absolute IPs, but rather in how they were affected by the delay to reward delivery within participants, it was considered unnecessary to randomise the order of delays in the present procedure.

Given the motivation of participants in the present study to participate as a requirement of their University programme, and not just to earn the monetary reward offered, it could be argued that those who presented rapid discounting may have hurried the task. However, as this only seemed to be three participants (P2, P11 and P23), it does not seem to have been a major problem.

As participants in the present study were university students rather than the adolescents that the CCT was designed for, one could question the degree to which they valued the monetary rewards offered. University students were likely to have dealt with larger sums of money than adolescents with BESD, and therefore may have valued the same amounts less. The degree to which the CCT and the DAA (R) would be suitable for use with the target population sample of adolescents with behavioural, emotional and social difficulties (BESD) therefore remains to be tested.

In accordance with findings by Mitchell (1999), it was expected that participants would take longer to make more self-controlled choices and respond faster

when choosing the more immediate (impulsive) option, thus indicating the possibility of increased cognitive process involved in more self-controlled choice. However in Part I and II, mean RT was similar for both self-controlled (LL) and impulsive (SS) choices, thus leaving the question as to whether impulsive choices are responded to faster than self-controlled choices unclear.

There was no evidence of a relationship between IPs and RT in Part I of Experiment 4. However, results from Part II provided evidence of a moderate correlation between IP and RT at the 60s delay, and combined results showed mean IP and area under the curve were significantly correlated with mean RT. This indicates that the more self-controlled choices participants made, the slower they were at responding to the choice options, and is consistent with suggestions by Kirkeby and Robinson (2005) that increased consideration was involved in making more self-controlled choices. Although similar correlations were produced, the area under the curve produced moderately stronger correlations with other measures than the mean IP.

With regard to the self-report measures of impulsivity and mindfulness, part I results revealed no significant correlations with IPs, RTs and self-report or between the two self-reports. Part II results showed no significant correlations between the self-reports and other measures, and although the Junior I.6 and CAMM were more closely related, the correlation remained non significant. Results from part I and II combined however, showed a moderately significant negative relationship between the Junior I.6 and the CAMM, supporting initial predictions and other evidence in Experiment 4 to suggest higher impulsivity is related to lower mindfulness.

In spite of this, scores on the self-report measures should be treated with caution as they were designed for use with children rather than adults. It seems reasonable to suggest this as a possible explanation for why the majority of participants scored between 40 and 60 percent on the CAMM, causing a limited range of measured mindfulness, which may in turn have led to a lack of significant correlations between self-reports and other measures. However, as mentioned previously, such a lack of consistency between behavioural and self-report measures has been reported previously. As suggested by Reynolds, Ortengren, Richards and De Wit (2006), it could be that the self-report and behavioural tasks measured different aspects of impulsive choice.

As mentioned previously, the finding that mean indifference points (and hence more self-controlled choices) were moderately positively correlated with mean response times (Table 3.12) provides further evidence that more mindful awareness might be involved in making self-controlled choices than in making impulsive choices, whereby individuals who make more self-controlled choices take more time to respond to rewards differing in size and delay. Increasing knowledge about the role of mindful awareness in choice between a small more immediate reward and a larger delayed reward could provide useful insight into impulse control disorders such as ADHD. Therefore, given the moderately significant negative relationship between the Junior I.6 and the CAMM in the general analysis of Experiment 4, and the limited research that has been done regarding this, further research assessing the relationships between such measures is important in considering possible interventions.

### **3.10 General Discussion**

Given the importance of using small real monetary rewards to measure delay discounting in young males with BESD, the DAA designed by Du et al. (2002) presented rewards as fractional amounts. However, in the present context there were concerns over whether the young males at the school would have difficulties understanding such fractional values presented in the CCT. Therefore, the CCT was re-programmed to present participants with values rounded to the nearest whole number, but maintaining adjustments calculated using the fractional (true) value that would have been presented in the original Du et al. version. Given the limited availability of adolescents with BESD to participate in the present research, undergraduate psychology students were recruited to participate in Experiment 3 and Experiment 4. Using undergraduates made it possible to assess the reliability of the modified rounded version (DAA (R)) by comparing it to data obtained using the original DAA version, as they possessed the necessary numerical skills to fully understand fractional values presented in the original DAA version.

Experiment 3 provided evidence that the adjustment procedure designed by Du et al. (2002) was an efficient method to converge on subjective indifference points across a range of delays. Both the original DAA and modified DAA (R) used in Experiment 3 produced data to suggest the CCT was an effective measure of delay discounting, as the students generally increased their rate of discounting as the delay to the larger reward increased. The results from Experiment 3 indicated that the rounded modification of Du et al.'s adjustment (the DAA (R)) developed in the present research produced results similar to those produced using the original Du et al. adjustment procedure (the DAA).

Therefore, the DAA (R) effectively enabled real, rather than hypothetical, rewards to be presented using real time delays to reward access. Consequently, application of the CCT with the DAA (R) could provide a more effective and valid measure of delay discounting in adolescents with emotional and behavioural difficulties, a population in which limited discounting research has been reported.

Given the repeated administration of similar choice tasks, it was possible that overall session duration had an effect on choice responding. In addition, it was considered valuable to determine approximate overall session duration before administering to the mixed sample of young males with BESD. Therefore, it was considered necessary to carry out a further study administering the CCT with the DAA (R) only, in addition to the two self-reports, to a further 40 undergraduate university students. However, as mentioned earlier, during testing the CCT required re-programming to correctly present delays of 15s, 30, 60 and 90 seconds. As in Experiment 4, data suggested that typical discounting behaviour was produced by most participants, providing evidence that the DAA (R) CCT was an effective measure of delay discounting in undergraduate psychology students.

Nevertheless, discounting behaviour in a number of participants was not typical, in that consistent responding across delays occurred, with 5 participants (out of the total 60 undergraduate students) making corner solutions. Therefore, delays were possibly too small for four of the 60 students and too large for one participant, but generally the delays used successfully bracketed the majority of participants' responding. It is probable that presenting participants with the

intended 90 second delay would have produced increased discounting in all participants in Experiment 3 and the first part of Experiment 4.

Discounting behaviour was moderately related to RT in the CCT in Experiment 4, suggesting that participants who responded more impulsively on the CCT (lower IPs) generally made their choices slightly faster, as had been predicted. Experiment 4 results indicated similar mean RTs for impulsive and self-controlled choices, however data from Experiment 3 showed that participants responded slightly slower when making more self-controlled choices, thus providing some support for original predictions and findings from Mitchell (1999) and Kirkeby and Robinson (2005). According to Kirkeby and Robinson, it is possible that such increased RT is due to increased deliberation in making self-controlled choices.

To further determine whether such a relationship existed, the Junior I.6 and CAMM scores were correlated with the RT and discounting data. Initial predictions were that participants making more impulsive choices would make choices more quickly, and would produce higher impulsivity scores on the Junior I.6 and lower mindfulness scores on the CAMM than participants making more self-controlled choices in the CCT. Results from Experiments 3 and 4 showed the CAMM and Junior I.6 did not correlate with mean IP, area under the curve, or mean RT. The correlation between the CAMM and Junior I.6 was not significant in Experiment 3. However, Experiment 4 (Parts I and II combined) results showed a significant negative correlation between the CAMM and the Junior I.6, suggesting more mindful students were less impulsive. Although this result supports initial predictions, it could be argued that data obtained from

self-reports in Experiments 3 and 4 were unreliable as they were specifically designed for use with children rather than adults used in these studies.

The results of the studies in the present chapter provide some indication that there may be a link between impulsivity and mindful self-awareness. It therefore remains plausible to examine whether improving mindful self-awareness could increase self-control and decrease impulsive behaviour. However, the degree to which different types of measure assess impulsivity appears somewhat unclear from the findings presented here. Previous research by Reynolds et al. (2006) suggested the possibility of different measure types assessing different forms of impulsivity. It appears that more research is required to determine whether this is indeed the case, and future research in the present project endeavoured to approach such ambiguity.

Findings from Experiments 3 and 4 provided evidence to suggest that the novel computer choice task (CCT) and the modified adjustment procedure developed by Du et al. (2002) were effective in measuring delay discounting in university students. However, it highlights potential difficulties in applying existing delay discounting tasks and associated adjustment procedures to research with populations such as adolescents with BESD. As the present project was directed towards measurement and intervention strategies to facilitate self-control and the self-regulation of behaviour in adolescents with BESD, it was necessary for Experiment 4 to be repeated using a mixed sample of young males from the participating school.

## **Chapter 4: Experiment 5**

### **The DAA (R) and Relations Between Measures of Impulsivity and Mindfulness in Adolescents with BESD**

#### **4.1 Introduction**

Having modified the adjustment procedure developed by Du et al. (2002) and concluded that it functioned as a suitable substitute in presenting rounded reward values to university students, it was necessary to assess its application to our target sample of adolescents with BESD. Although studies assessing relations between different measures of impulsivity have reported mixed results (e.g., Madden, Petry, Badger & Bickel, 1997; Coffey, Gudleski, Saladin & Brady, 2003; Vuchinich & Simpson, 1998), to further assess the validity of the CCT (using the DAA (R)) as a measure of impulsive choice, additional measures (including self-reports and behavioural observations) were taken.

Furthermore, one of the primary aims of the present project was to determine whether there was a link between impulsivity and self-awareness (a notion supported by findings from, e.g., Lakey, Campbell, Brown & Goodie, 2007). Results from Experiment 4 indicated a moderate relationship between two self-report scales (the Junior I.6 impulsivity scale and a mindfulness measure: the CAMM). However, few relationships were found between these and discounting (IP) or response time (RT) data. It was possible that the self-report scores were ineffective with the undergraduates used in Experiments 3 and 4, because they were designed for use with children and adolescents. Therefore it was necessary to administer the two self-reports to the target sample of adolescents



to explore the relationship between impulsivity and mindful self-awareness in that group.

Classroom behaviour and staff ratings were additionally highly relevant to the present research in assessing the ecological validity of the CCT. Solanto et al. (2001) assessed validity of a choice task similar to that developed in the present project and compared it to observations of behaviour taken using the Classroom Observation Code (COC; Abikoff & Gittelman, 1985), and the Conner's parent and teacher questionnaires to assess impulsivity in ADHD and control children. As reported by Solanto et al., the Conner's questionnaires have been extensively used in ADHD research, and continue to be a widely used professional tool in ADHD assessment (e.g., see the National Resource Centre on ADHD). However, as the current research was directed to studying impulsivity rather than the multi-dimensional facets involved in ADHD, a simple rating scale was required for use in the present study (see section 4.2.2 below).

Therefore, Experiment 5 was designed to assess the suitability and effectiveness of administering the CCT (the DAA (R)) to the target sample of adolescents with behavioural, emotional and social difficulties. In relation to this was the additional question of whether other measures of impulsivity would correlate with IPs obtained by the CCT. As in the study by Solanto et al., (2001), to assess the validity of the CCT, the Junior I.6 (Eysenck, Easting & Pearson, 1984) was administered, and data were obtained on classroom behaviour and staff ratings of pupils' general impulsivity (see section 4.2.2).

Furthermore, an initial proposal of the present research was that if impulsivity is related to the degree to which one is self-aware, one might expect response times (RTs) to be smaller when impulsive choices are made and larger for more self-controlled choices. However, although explored in previous experiments within the current project, the question of whether RT differed for more immediate (SS) and more self-controlled choices remained unresolved. Consequently, as results for RTs remained relatively variable in previous studies in the present project, with no clear finding of a difference in RT between SS and LL choices, the question remained of whether RT would differ significantly between more impulsive choices and more self-controlled choices in young males with BESD, using the revised CCT. In addition, the opportunity to examine whether RT correlated with IP, self-reports, staff ratings and classroom observations was presented.

Since the self-report measures were designed for children and adolescents, it was hoped that they would be more likely to produce valid data than that obtained in Experiment 4. Therefore, more valid comparisons could be made to determine whether impulsivity on one measure is indicative of impulsivity on another and whether a link between mindfulness and impulsivity exists in adolescents with BESD.

## **4.2 Method**

### **4.2.1 Participants**

Twenty-eight male adolescents with a range of behavioural, emotional and social difficulties (BESD) were recruited from the participating school (see section 2.2.1 for details). Details of each individual's age and diagnosis are

displayed in Table 4.1. All participants were enrolled on residential placements at the school, with the exception of two participants who attended daily. Participants ranged in age from 12 to 19 years, with a mean age of 16 years and 6 months ( $SD = 1.9$ ) and had not participated previously in research presented within the current thesis. Consent to conduct research at the school had been granted, passive consent was obtained from parents/carers and participants were required to sign consent forms. Participants were excluded from participating in the research if any consent was not given or parents/carers expressed concerns regarding the research (a total of two participants).

Table 4.1 *Diagnosis of each participant in Experiment 5.*

P No	Age (years)	ADHD	ASD	AS	CD	BESD	Schizophrenia
P2123	12	<b>X</b>				-	
P1517	16		<b>X</b>			-	
P236	15	<b>X</b>				-	
P916	16	<b>X</b>		x		-	
P13625	15			<b>X</b>		-	
P116	14		x		<b>X</b>	-	
P58	13					<b>X</b>	
P1310	16	<b>X</b>	x			-	
P1626	16					<b>X</b>	
P2120	12					<b>X</b>	
P196	17	x	<b>X</b>			-	
P56	17	<b>X</b>		x		-	
P1323	18		<b>X</b>			-	
P48	18	<b>X</b>	<b>X</b>			-	
P717	18	<b>X</b>				-	
P1315	17	<b>X</b>				-	
P1022	18		<b>X</b>			-	
P525	18					<b>X</b>	
P187	16			<b>X</b>		-	
P1615	18	<b>X</b>		x		-	
P215	17					<b>X</b>	
P1926	17					-	<b>X</b>
P617	17	x		<b>X</b>		-	
P165	16		<b>X</b>			-	
P137	19					<b>X</b>	
P2217	18					<b>X</b>	
P2319	19		<b>X</b>			-	
P1512	18		<b>X</b>			-	

*Note: Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Asperger's Syndrome (AS), Conduct Disorder (CD), Primary diagnosis (X), Secondary diagnosis (x), Associated difficulties (-).*

#### **4.2.2 Materials**

The DAA (R) version of the computer choice task (CCT) used in Experiment 4 was presented to participants on a laptop and participants made choices using a joystick (see section 2.2.2 for full details of materials used for the CCT). Two questionnaire sheets included the Junior I.6 Impulsivity scale (Eysenck et al., 1984) and the Child Acceptance and Mindfulness Measure (CAMM; Greco & Baer, 2005), as previously used in Experiment 4 in the current thesis. Consent forms, instructions, briefing and debriefing documents were also used (see Appendices N and O).

Additional measures of participants' impulsivity included the Classroom Observation Code (COC; Abikoff & Gittelman, 1985) and a general impulsivity rating scale (the Staff Impulsivity Rating: SIR) for staff to complete. The SIR was designed for use in the present study to obtain a measure of the degree of impulsive behaviour exhibited by each participant throughout the day. The SIR was a brief, easy to use measure on which staff rated each pupils' general impulsivity in school on a 1 (never) to 10 (always) point scale. However, it must be noted that the SIR has not been shown to be reliable or valid. Each participants' initials were typed on the left side of the SIR scoring sheet and staff were required to highlight the degree to which they considered each pupil to be impulsive (see Appendix P).

The COC comprises of a total of 12 behaviour observation coding categories (Table 4.2), from which Solanto et al. (2001) selected those considered most relevant to the core characteristics of ADHD. To assist analysis of classroom observations, Solanto et al., (2001) grouped behaviours into composite

measures (outlined in Table 4.2), including: Interference (*I*) and Solicitation (*S*); Physical aggression (*A*), Threat/Verbal Aggression to Children (*AC*) and Threat/Verbal Aggression to Teacher (*AT*); Off-task (*X*); Gross Motor-Standing (*GMS*) and Gross Motor-Vigorous (*GMV*). It seems reasonable to argue that each of these behaviours involve some form of impulsivity, and therefore were recorded in observations in the present study. Each behaviour observation was divided into sixty-four 15 second intervals (a total of 16 minutes) and all observations were conducted by the experimenter.

Table 4.2 *Behaviours, codes, and composite measures for classroom observations (COC) carried out in Experiment 5.*

<b>Behaviour and Code</b>	<b>Composite Measure</b>
Interference ( <i>I</i> )	Impulsive Behaviours
Solicitation of Teacher ( <i>S</i> )	
Off-Task ( <i>X</i> )	Inattentive Behaviours
Gross Motor Standing ( <i>GMS</i> ), Gross Motor Vigorous ( <i>GMV</i> )	Hyperactive Behaviours
Physical Aggression ( <i>A</i> )	Aggressive Behaviours
Threat/Verbal Aggression to Children ( <i>AC</i> )	
Threat/Verbal Aggression to Teacher ( <i>AT</i> )	
Absence of Behaviour ( <i>AB</i> )	

According to Abikoff, Gittelman-Klein and Klein (1977) the classroom behaviour of normal and hyperactive children was successfully distinguished using the COC, and has been reported to exhibit "face validity as a measure of impulsive

behavior" (Solanto et al., 2001, p. 218). The COC has been used to observe classroom behaviour over successive weeks in an intervention study (Klein & Abikoff) and according to Pelham, Fabiano and Massetti (2005) and Klein and Abikoff (1997), the COC was sensitive to treatment effects. However, although it appears that Information on test-retest reliability of the COC is limited, Pelham et al. reported that ADHD groups "had greater variability across categories over successive observations" (p. 458). Nonetheless, Pelham et al. maintained that the COC exhibited acceptable reliability and validity (p. 462).

To enable the experimenter to code behaviour using the COC reliably (without the need to visually monitor time), an MP3 file was designed in which a piano tone sounded every 15 seconds (equivalent to one observation interval) and a trumpet tone sounded after every four minutes (sixteen 15 second intervals) for a total of 32 minutes (sixty-four 15 second intervals). Observation data were recorded onto a scoring sheet and pre-observation notes were recorded using the observer data sheet (both designed for use with the COC, see Abikoff & Gittelman, 1985).

#### **4.2.3 Design and Procedure**

A within-subjects design was used in which each participant received each measure in the same order to examine whether the modified rounding adjustment in the CCT provided an effective measure of delay discounting in adolescents with BESD. The initial task administered was the CCT, followed by the Junior I.6 and the CAMM (as in Experiment 4). Although using a fixed order approach was likely to produce order effects, it was necessary to enable closer

comparison between and within participants in the small sample of adolescents available, as all participants were likely to be similarly affected.

Prior to participation, participants were briefed, invited to sign a consent form, and given the instructions. On completion of the testing session, the debrief was read aloud and the experimenter provided participants with a typed debrief to retain for later reference if required.

Delays used in the CCT for Experiment 4 appeared to effectively bracket discounting for most participants, therefore the same delays were used in the present study (15s, 30s, 60s and 90s). However, according to reports from members of staff at the school and pupils' statements of special educational needs, several participants exhibited difficulties in sustaining attention. Therefore, it was expected that steeper rates of discounting would be produced by adolescents with BESD, than the undergraduate students in Experiment 4. The initial 15s delay remained an unpaid practice for participants to become familiar with the CCT. Participants were permitted to ask questions during and after completion of the 15s practice.

The CCT procedure was the same as for Experiment 4 (see the general method section 2.2.3 for details of the CCT). The delayed amount remained fixed at 10p throughout the task, and the immediate value was adjusted according to the DAA (R) outlined in Experiment 3 (see section 3.3.3 for full details). During the CCT, response time (RT) continued to be recorded by the program to assess the prediction that RT would be less for adolescents' choices towards more



immediate rewards and larger for choices towards the delayed, larger reward option.

To assess the external validity of the CCT and explore relations between impulsivity measures and between impulsivity and mindfulness, additional measures were used in Experiment 5. Two members of full-time staff at the school (one responsible for therapeutic care and behaviour management, the other from education, both of whom had frequent contact with the pupils) were asked to complete the staff impulsivity rating scale (SIR).

As in Solanto et al. (2001), classroom observations were carried out to provide a measure of impulsive behaviour during periods of taught lessons using the COC. All testing sessions and observations were carried out between the school hours of 09:15 and 15:15 in Literacy classes consisting of between two and six pupils.

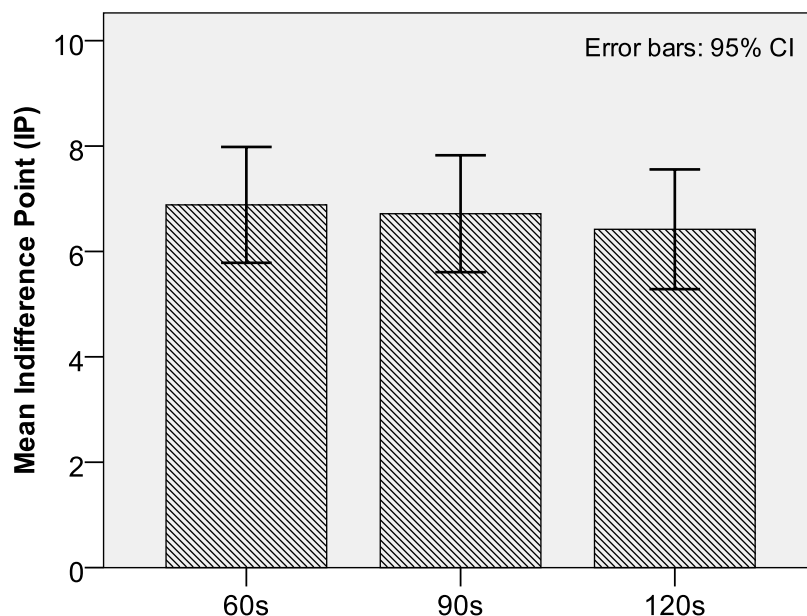
Discounting data were calculated and indifference curves plotted to determine the degree of discounting in adolescents with BESD, and to determine the validity of the CCT. In addition, correlations between data obtained from the CCT (Computer Choice Task), RT (response time), the two self-report measures (the Junior I.6 and the CAMM), staff ratings (SIR) and behavioural observations (COC) were explored.

### **4.3 Results**

The initial delays of 15s (practice), 30s, 60s and 90s appeared to be highly tolerated by four (P2123, P236, P916 and P13625) of the five initial participants,

with P1517 as the only participant to discount the larger reward as the delay to it increased (see Figure 4.2). Consequently, delays were increased to 30s (practice), 60s, 90s and 120s for the remaining 23 participants. P137 responded slowly to each choice he made, and his understanding of numerical values was questioned, therefore data obtained from this participant were removed from analyses presented in this section. For reasons specified in previous experiments carried out in the present project, the unpaid practice delay condition was likely to have produced inconsistent results, therefore data were explored and analysed only for the three main delays participants received.

As with previous studies in the current project, mean IPs were calculated for the 60s ( $n = 27$ ), 90s ( $n = 27$ ) and 120s ( $n = 22$ ) delay conditions. Figure 4.1 shows a very slight decrease in IPs as the delay to the LL reward increased.



*Figure 4.1* Mean indifference points with associated error bars (at the 95 percent confidence interval) produced by adolescents with BEDS at the 60s, 90s and 120s (seconds) delays.

Tests for normality (Shapiro-Wilk) revealed that the distribution of IP data at the 60s delay ( $D(27) = .86, p < .01$ ) and at the 90s delay ( $D(27) = .87, p < .01$ ) significantly deviated from normality. The distribution of IP data at the 120s delay however, was normal ( $D(22) = .91, p = .05$ ). Given the small differences between mean IPs displayed in Figure 4.1, it was unlikely that any differences between delays were significant. Nonetheless, to determine whether any differences were significant, a Friedman's ANOVA was performed. As expected, the Friedman's test revealed that there was no significant main effect of delay on IP:  $\chi^2(2, n = 22) = 1.34, p = .51$ .

Figure 4.2 illustrates highly varied responding between participants. Specifically, six participants (e.g., P2120 and P1323) produced typical discounting behaviour, ten participants (e.g., P58 and P165) maintained relatively stable IPs across delays (of which five participants reached corner solutions, consistently choosing the large delayed reward), seven participants (e.g., P717 and P1512) varied their responding between delays unsystematically, and four participants' IPs increased as the delay to the LL reward increased (e.g., P1315 and P1926). Of the participants with unsystematically varying IPs, three participants increased their IP in the final delay (e.g., P1615) and four participants increased their IP from the 60s to the 90s delay then produced a lower IP at the final 120s delay (e.g., P56 and 1512).

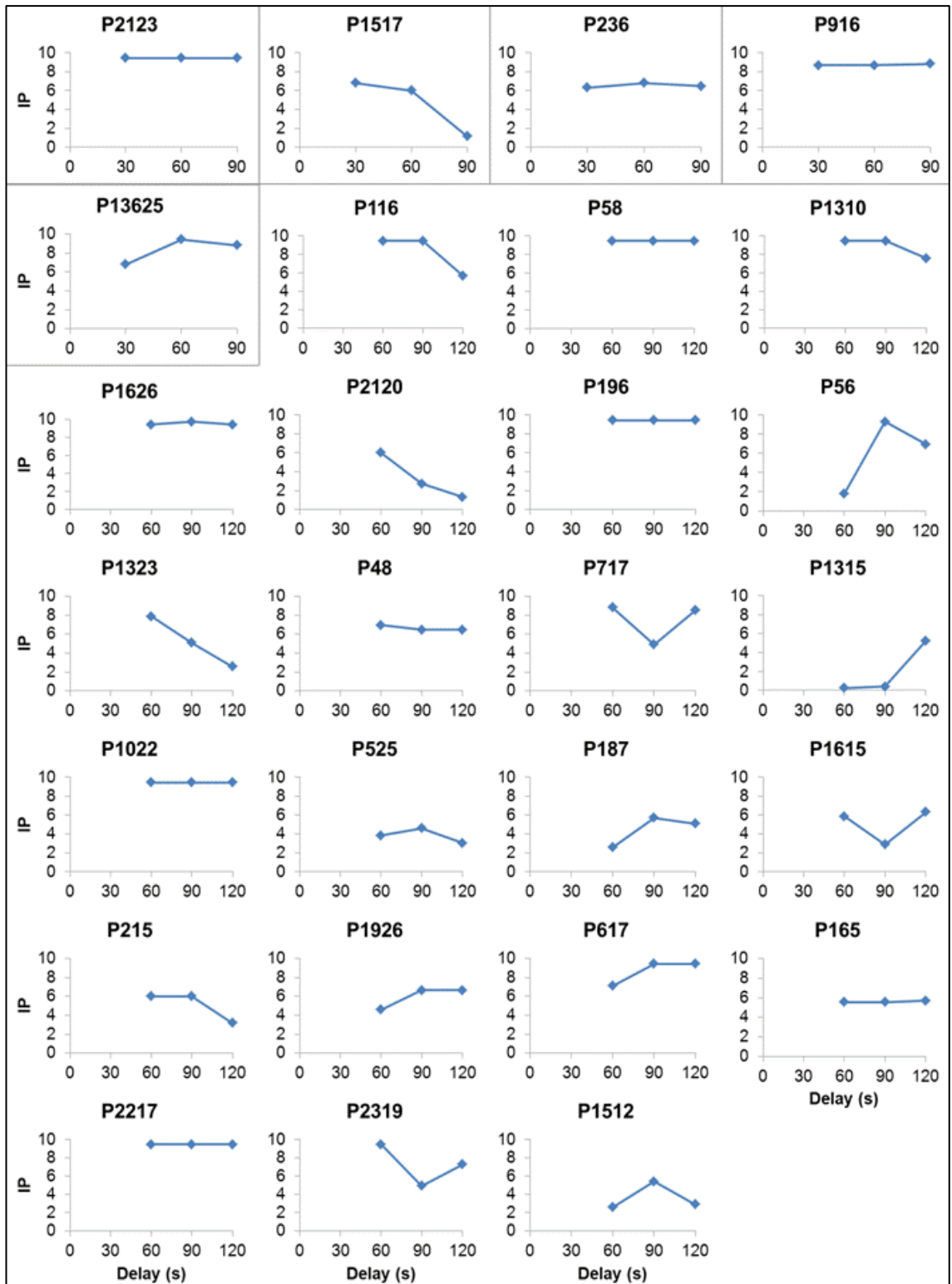


Figure 4.2 Indifference point (IP) curves obtained from choice responding across delays. The five indifference curves (P2123, P1517, P236, P916 and P13625) framed in black at the top of this figure display delays of 30, 60 and 90 seconds (s).

Response times (RTs) towards more immediate (RTSS) rewards and towards delayed (RTLL) rewards were calculated at each delay and across delays. It was expected that RT would be larger for choices towards the larger delayed reward (RTLL). However, as can be seen in Figure 4.3, participants generally responded similarly across the three main delays of 60s ( $n = 27$ ), 90s ( $n = 27$ ) and 120s ( $n = 22$ ), with slightly smaller mean RTs at the 120s delay. It is important to note that since participants chose SS and LL rewards, the number of trials from which RTSS and RTLL were calculated from differed between delays. Specifically, the number of trials were: 73 (60s RTSS), 89 (60s RTLL), 72 (90s RTSS), 90 (90s RTLL), 71 (120s RTSS) and 61 (120s RTLL).

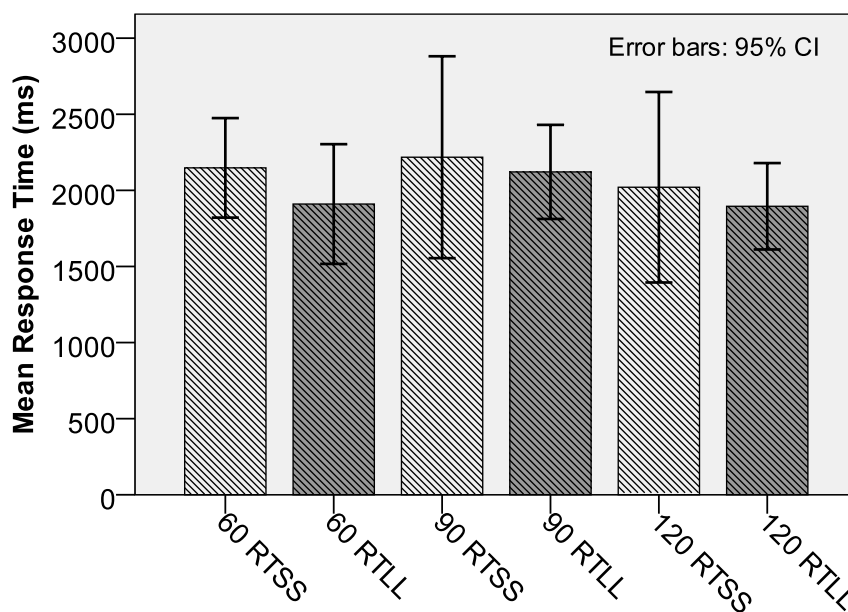


Figure 4.3 Mean response times (RTs) at each delay and across all main delays for the larger delayed reward (RTLL) and smaller more immediate (RTSS) choices.

Mean RTSS and mean RTLL were calculated from the 3 main delays participants received. Figure 4.3 shows that mean RTSS was slightly larger ( $M = 2168$ ,  $SD = 931$ ,  $n = 27$ , total SS trials = 287) than mean RTLL ( $M = 1967$ ,  $SD = 931$ ,  $n = 27$ , total LL trials = 287).

= 582,  $n = 27$ , total LL trials = 331). Tests for normality (Shapiro-Wilk and histogram distributions) revealed that several distributions of RT data at different delays were significantly deviated from a normal distribution. Specifically, RTSS at the 90s delay ( $D(27) = 74$ ,  $p < .01$ ) and RTSS at the 120s delay ( $D(22) = .67$ ,  $p < .01$ ) both deviated significantly from the normal distribution. In response to the deviations from normality of RT distributions, data were analysed using non-parametric tests.

To determine whether there were statistically significant differences between RTLL and RTSS at different delays, a 3 (delay: 60, 90, 120 seconds) by 2 (reward: SS versus LL) within-participants ANOVA was performed. Since the first five participants (P2123, P1517, P236, P916 and P13625) received slightly different delays, their data were excluded from the ANOVA. To compensate for the deviations from normal distribution, the significance level was reduced to  $p < .01$ . Results from the ANOVA revealed no statistically significant main effect of delay on RT, no significant main effect of reward (SS and LL), and no statistically significant interaction between delay and reward on RT (see Table 4.3).

Table 4.3 *Results obtained from the two-way within-participants ANOVA in Experiment 5 ( $n = 22$ ).*

Variable	<i>df</i>	<i>F</i>	$\eta^2$	<i>p</i>
Delay	2 (42)	.47	.02	.62
Reward	1 (21)	.81	.04	.38
Delay*Reward	2 (42)	.01	.00	.99

In response to finding that RTs were generally larger when participants made choices towards more immediate rewards, and in consideration of findings by Robles and Vargas (2007), it seemed necessary to explore whether response times increased the closer a participant came to their indifference point. Since a modified version of Du et al.'s DAA was used to converge on IPs, IPs were reached in the final sixth choice trial (see section 1.4.1, Figures 1.1 and 1.2). Therefore, if the theory proposed by Robles and Vargas was supported, one would expect RT to be largest in choice trial number six. Response time data for each of the young males participating are displayed in Figure 4.4.

Response time (RT) data in Figure 4.4 show highly varied RTs between individuals, hence it was necessary to display RT data using different scales to illustrate RTs. Figure 4.4 shows that for each delay, P1517 gradually increased his RT across the trials, with his slowest response times at trial number six. Several participants appeared to have larger RTs when reaching their IP at different delays. Specifically, P2123 responded most slowly in choice trials five and six for the 30s delay, P236 and P13625 responded most slowly in choice trial six in both the 30s and 60s delays, and P916 responded most slowly in choice trial six at the 30s and 90s delays. P2120, P196, P215 and P1926 responded most slowly in choice trial six at the 60s delay, P1512 responded most slowly in trial number six during the 90s delay and P1323, P717 and P525 responded most slowly in trial number six at the 120s delay. Several of the boys (e.g., P58, 56 and P2319) gradually responded more quickly as they reached their IP, but for most of the participants, RTs appeared unsystematically varied.

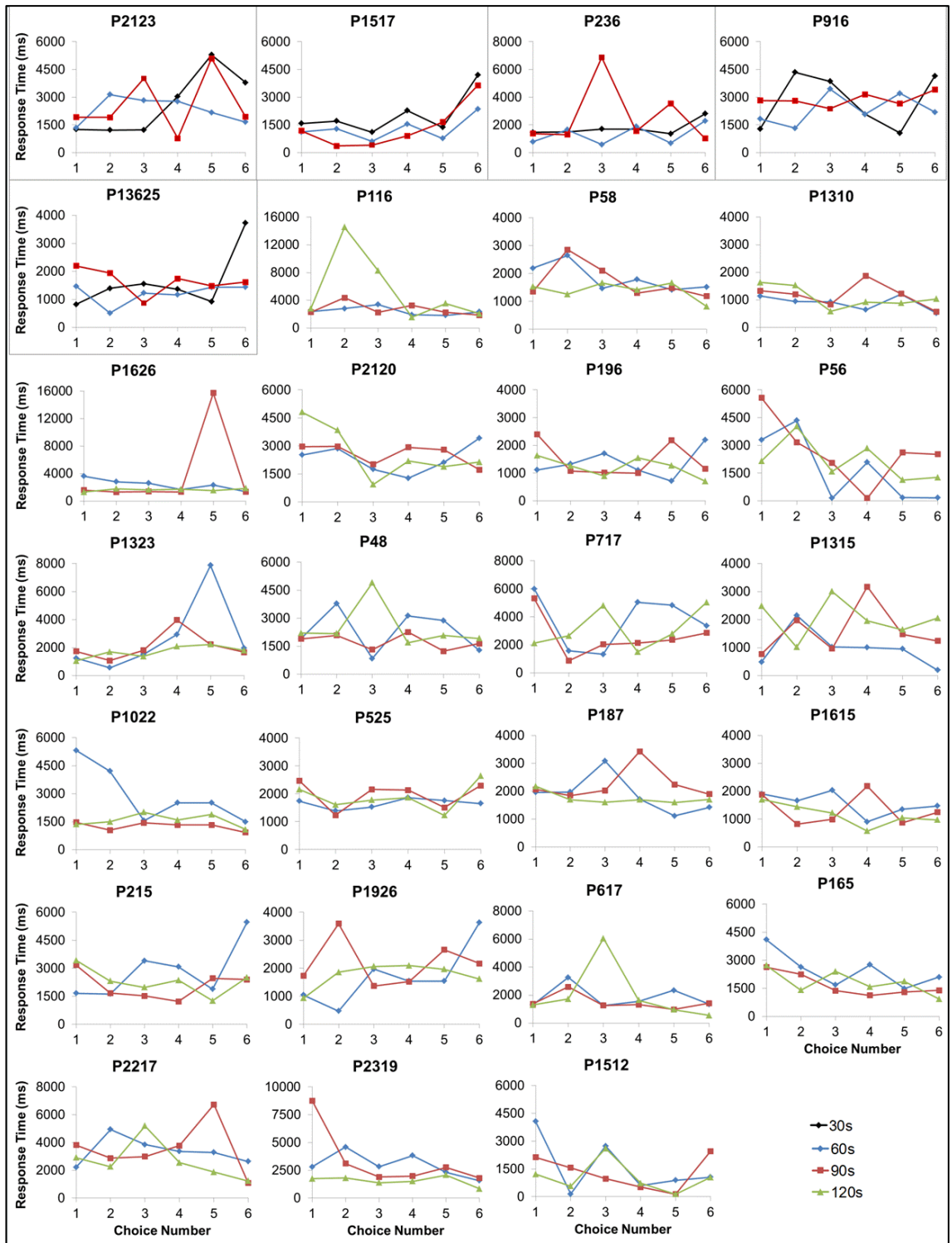


Figure 4.4 Response times produced by each participant for each choice trial in each of the three delays they received (note that scales differ).



Given that several of the distributions of IP and RT data were significantly deviated from the normal distribution, to explore relations between different impulsivity measures, RT and mindfulness, Spearman's rho correlations were performed. As mentioned previously, analysis excludes all data obtained at the 15s and 30s delays as these were practice tasks for the majority of participants. Staff ratings of pupils' general impulsivity were obtained from two members of staff who worked closely with the pupils and are referred to as SIR (I) and SIR (II).

Unsurprisingly, but providing evidence for similarities between delays and lending confidence to the reliability of the general method, IPs at each delay were significantly correlated with IPs at the other delays, and RTs correlated significantly between delays. However, as can be seen in Table 4.4, no statistically significant correlations were found between IP and RT data. Similarly, no significant correlations were found between mean IP and either self-report measure.

Table 4.4 Spearman's ( $r_s$ ) correlations between indifference points (IP) and response times (RT), and self-report measures.

Measure 1	Measure 2	$r_s$	$p$	$n$
Mean 60 IP	Mean 60 RT	.31	.12	27
Mean 90 IP	Mean 90 RT	.16	.42	27
Mean 120 IP	Mean 120 RT	-.13	.55	22
Mean IP (60,90,120)	Mean RT (60,90,120)	.22	.27	27
Mean IP (60,90,120)	Junior 1.6	-.02	.93	27
Mean IP (60,90,120)	CAMM	.04	.84	27

Furthermore, Table 4.5 shows that mean RT was not significantly correlated with either self-report measure, or the SIRs completed by either member of staff.

Table 4.5 Spearman's ( $r_s$ ) correlations between mean response times (RT) taken from the 60, 90 and 120s delays and the Junior 1.6, CAMM and the SIR (Staff Impulsivity Rating: completed by staff members I and II).

Measure 1	Measure 2	$r_s$	$p$	$n$
Mean RT (60,90,120)	Junior 1.6	-.19	.35	27
Mean RT (60,90,120)	CAMM	-.34	.09	27
Mean RT (60,90,120)	SIR (I)	.31	.11	27
Mean RT (60,90,120)	SIR (II)	.05	.82	27

The Junior 1.6 was significantly correlated with the SIR obtained from one of the members of staff (II), indicating that individuals who scored highly on the Junior 1.6 impulsivity self-report measure tended to be rated as more impulsive by the

second staff member (Table 4.6). However, the CAMM did not significantly correlate with SIR from either staff member. Although not significantly so, the two staff ratings were closely related (Table 4.6). There were no significant correlations between either member of staff's impulsivity ratings and IPs or between each member of staff's ratings and classroom behaviour (COC).

Table 4.6 Spearman's ( $r_s$ ) correlations between the self-report scales (Junior I.6 and the CAMM), mean IPs (taken from the 60, 90 and 120s delays), COC and the SIR and between the two SIRs.

Measure 1	Measure 2	$r_s$	$p$	$n$
Junior I.6	SIR (I)	.07	.72	27
Junior I.6	SIR (II)	.43	.03*	27
CAMM	SIR (I)	-.04	.85	27
CAMM	SIR (II)	-.29	.15	27
SIR (I)	SIR (II)	.33	.09	27
Mean IP (60,90,120)	SIR (I)	.14	.48	27
Mean IP (60,90,120)	SIR (II)	-.23	.25	27
COC (Total)	SIR (I)	.06	.80	18
COC (Total)	SIR (II)	-.04	.89	18

Note: \*Correlation is significant at the  $p < .05$  level (two-tailed).

Data obtained from the Classroom observation code (COC) were separated into four composite measures of behaviour suggested by Solanto et al. (2001) and each calculated as a percentage of the maximum possible total score. Due to time constraints and to participants' academic commitments, behavioural observation data were obtained from only 18 of the 28 participants. According to

tests of normality (Shapiro-Wilk and histogram distributions) COC data significantly deviated from a normal distribution. Therefore COC data were analysed using non-parametric tests. Spearman's rho revealed several significant correlations within COC measures: impulsive behaviour was significantly correlated with inattentive behaviour and hyperactive behaviour, and inattentive behaviour was significantly correlated with hyperactive behaviour (Table 4.7). However, aggressive behaviour did not significantly correlate with impulsive, inattentive or hyperactive behaviours (Table 4.7).

Table 4.7 Spearman's ( $r_s$ ) correlations between composite measures of behaviour (COC).

Measure 1	Measure 2	$r_s$	$p$	$n$
Impulsivity	Inattention	.58	.01*	18
Impulsivity	Hyperactivity	.55	.02*	18
Impulsivity	Aggression	.31	.21	18
Inattention	Hyperactivity	.67	<.01**	18
Inattention	Aggression	-.10	.69	18
Hyperactive	Aggression	.08	.75	18

Note: \*\*Correlation is significant at the  $p < .01$  level (two-tailed). \*Correlation is significant at the  $p < .05$  level (two-tailed).

Spearman's rho correlational analysis revealed no statistically significant correlations between mean IP and the observation data, or between RT and overall observed behaviour (Table 4.8). However, mean IP and the percentage of aggression observed in the classroom were closely related (Table 4.8).

Table 4.8 Spearman's ( $r_s$ ) correlations between total and composite measures of behaviour and mean indifference points (IP) and mean response time (RT) taken from the 60, 90 and 120s delays.

Measure 1	Measure 2	$r_s$	$p$	$n$
Mean IP (60,90,120)	COC (Total)	.01	.97	18
Mean IP (60,90,120)	Impulsivity	.00	1	18
Mean IP (60,90,120)	Inattention	-.06	.8	18
Mean IP (60,90,120)	Hyperactivity	.23	.36	18
Mean IP (60,90,120)	Aggression	.45	.06	18
Mean RT (60,90,120)	COC (Total)	-.12	.63	18

Distributions of the Junior I.6 and CAMM data were found to be normally distributed, and a Pearson's correlational analysis was performed to determine the relationship between impulsivity and mindfulness. As displayed in Figure 4.5, the adolescents scored between 40 and 70 percent on the CAMM, suggesting that the problem of restricted range affected the coefficient. Nonetheless, scores obtained from the Junior 1.6 and CAMM were significantly negatively correlated ( $r = -.53$ ,  $p < .01$ ,  $n = 27$ ).

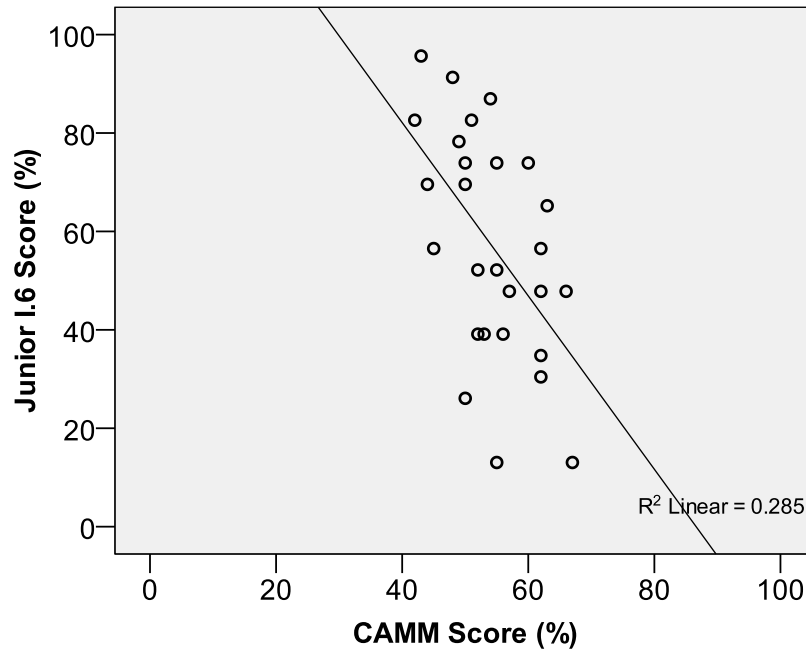


Figure 4.5 The negative correlation between scores obtained on the Junior I.6 and scores obtained on the CAMM.

On the basis of discounting data obtained from the CCT, participants appeared to fall into four main responding groups: participants who discounted (i.e., IP decreased as delay increased,  $n = 7$ ), participants who produced similar IPs across delays (i.e., IP was consistently stable across delays,  $n = 10$ ), participants who increased their IPs across the delays (i.e., IP increased as delay increased,  $n = 4$ ) and participants who produced unsystematically varying IPs (i.e., IPs at each delay varied,  $n = 6$ ). Figure 4.6 indicates that participants who maintained similar IPs across delays had the largest mean IP ( $M = 8.4$ ,  $SD = 1.5$ ,  $n = 10$ ), and therefore generally made more self-controlled choices than participants who discounted, varied, or who presented increased IPs. However, the lowest mean IPs were produced by participants who discounted ( $M = 5.7$ ,  $SD = 2.2$ ,  $n = 7$ ) and varied ( $M = 5.6$ ,  $SD = 1.5$ ,  $n = 6$ ) their responding across delays.

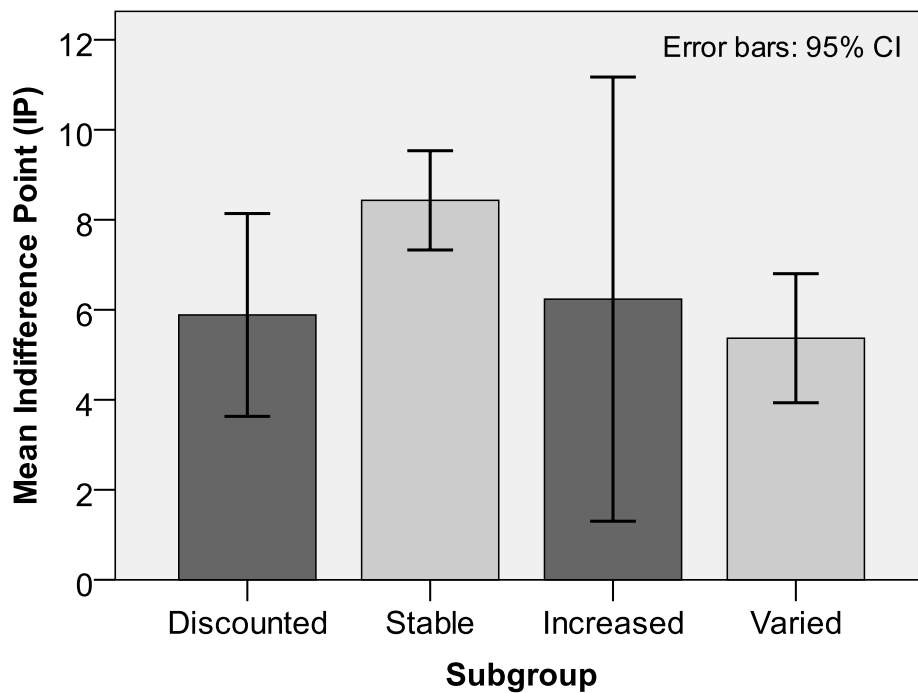


Figure 4.6 Mean Indifference Points (IP) and associated error bars (95 percent confidence interval) obtained across the three main delays for each of the four subgroups in the CCT.

In relation to the literature reviewed in Chapter 1, one of the characteristics of ASD is a tendency towards repetitive behaviours and routines. Therefore, it seemed possible that the boys in the 'stable' subgroup, might have been those with a diagnosis of AS or ASD. However, of the ten young males who produced stable IPs across delays, two had ADHD, two were diagnosed with ASD, three had general BESD and three were diagnosed with ADHD and AS/ASD.

Results appeared to show high variability in responding between participants, from which four subgroups of response type emerged (discounting, stable, increasing and varying). Interestingly, participants were tolerant of delays that had been discounted by university students in Experiment 4. Response times

were slightly longer for choices towards immediate rewards, and while the Junior I.6 and the CAMM were negatively related, few correlations were apparent between self-reports and other measures.

#### **4.4 Discussion**

Results showed high variability between the choice responding of adolescents with BESD, with no significant effect of delay on IP. It is possible that the effect of delay was found to be not significant because of the low powered analysis produced by the small sample size and the heterogeneity of the sample. Although it was expected that there would be large individual differences between the subjective value of rewards differing in size and delay to reward receipt, discounting only occurred in six of the total 27 participants. Several participants presented stable indifference points across delays, some of whom reached corner solutions, mostly choosing larger delayed rewards. This was true even after delays were increased because the initial delays were highly tolerated. It was considered whether such repetitive responding might be due to more general characteristics of ASD, however, adolescents within the 'stable' subgroup had a variety of diagnoses.

Such high tolerance of delays previously discounted by university students was a surprising finding as it was expected that the adolescents would discount at higher rates than university students, due to symptoms of impulsivity and difficulties with sustained attention. It is possible that delays were not large enough to bracket adolescents' discounting, or the monetary reward was too highly valued. Although the token economy system at the school involved monetary rewards, the adolescents were likely to be less familiar with



accumulating money as they did in the CCT. Additionally, the maximum £1.80p reward amount was likely to have been valued more highly by the adolescents than the university students due to previous financial experience (e.g., through paid employment and university fees).

Alternative explanations for the high tolerance of delays concern the context and form of the choice task. As the CCT was carried out during school lessons it is possible that the adolescents chose the delayed reward more frequently to prolong time out of class. As reported by Malone (1981), children and adolescents have an ability to maintain attention for long durations when playing computer and video games. Therefore, although the CCT was repetitive and lacked attractive graphics, it is possible that as the choice task was presented in the form of a computer game participants were more liable to tolerate the delays. Consequently, it would be desirable to design a further study to determine the effect of context and form of choice task on delay discounting.

As participants were instructed that they would receive four sets of six choice trials it is possible participants who increased responding toward the delayed reward in the 120s delay may have been attempting to maximise profit in the final delay condition. Low indifference points during practice delays were the likely effect of receiving no money, and of unfamiliarity with the task.

Adolescents who varied their responses across delays could have been exploring the adjustment method. Previous research (e.g., Dixon et al., 1998) has successfully developed choice tasks to improve self-controlled responding through introducing schedules of reinforcement for delayed responding.

Delayed responding of participants in the present study (those who chose the larger reward more as the delay to it increased) may have similarly been reinforced, having observed more money accumulate in their container for delayed responses.

It appeared that the DAA (R) (modified from the adjusting procedure developed by Du, Green & Myerson, 2002) was more suitable for adolescents with BESD than the unrounded version (the DAA), as all participants (with the exception of P137, whose data were removed from analysis) appeared to understand the whole-number reward values.

Several significant correlations suggested internal consistency within measures, for example participants' responding at one delay predicted responding at another for both choice and response time. However, there were very few significant correlations between measures. For instance, composite measures of behaviour appeared unrelated to IPs. It is possible that the COC data were not sufficient to provide a representative measure of classroom behaviour, as due to time constraints only one 16 minute observation was carried out on 18 participants. Therefore, more COC data may be necessary to determine whether choice responding on the delay discounting task is related to undesirable behaviour. As mentioned previously, it is also likely that the small sample size and heterogeneity of the sample resulted in underpowered statistical analyses.

The COC used here was conducted using the methods of Solanto et al. (2001), and thus a selection of behaviours most relevant to the core symptoms of

ADHD were coded, leaving several behaviours out, such as 'Out-of-Chair'. However, it could be that the omitted behaviours are potentially relevant to the present project in assessing general impulsive behaviour in the classroom. Therefore, some advantage might be gained from using the COC in its entirety.

Despite the problem of restricted range, results showed a significant negative correlation between scores obtained on the Junior I.6 and the CAMM. Therefore, participants scoring more impulsively on the Junior I.6 scored less mindfully on the CAMM. This finding lends support for the idea that increasing mindful self-awareness could increase self-controlled responding and in turn facilitate more effective behavioural regulation (Lakey, Campbell, Brown & Goodie, 2007; Brown, Ryan & Creswell, 2007). However, there were relatively few between measure correlations in the present study. For example, the CAMM did not correlate with any other measures, and the Junior I.6 only correlated with one SIR. Furthermore, mean response times across participants showed that larger response times occurred when choosing more immediate rewards. Research involving larger participant samples and more fully developed impulsivity measures is therefore necessary to explore the link between response times, mindfulness and impulsivity.

A lack of consistency between discounting tasks and self-report measures has been reported previously (Reynolds, Ortengren, Richards & De Wit, 2006), and it might be that different measures assess different forms of impulsivity. In addition, the delay discounting task developed for use in the present project to measure impulsive choice in adolescents with BESD gave mixed results, suggesting the need to assess the effect of context and form of presentation on

participants' responding in order to determine its validity. Initial results appear to suggest the CCT has potential to provide a procedure for general use in which parameters can be set and adjusted according to specific experimental requirements. Further research into discounting at longer delays, and relations between other measures, could provide useful insight into the behaviour of adolescents with BESD.

The relationship between mindful self-awareness and impulsivity also remains unclear, but some of the present data indicate that more mindful individuals are less impulsive. If this is the case, the possibility of increasing mindful self-awareness through techniques such as mindfulness training may arise (e.g., Smalley et al., 2009).



## **Chapter 5: Experiment 6**

### **Context and Method Effects on Discounting**

#### **5.1 Introduction**

Results from Experiment 5 unexpectedly revealed that the adolescents with BESD presented a higher tolerance of delays, and hence made more self-controlled choices, than those made by undergraduate psychology students in Experiment 4. Those who are familiar with children and adolescents, including those with BESD, will be aware of the prolonged attention such individuals can demonstrate in playing computer and video games (as highlighted in Malone, 1981). It could be argued that such behaviour is surprising in individuals with BESD, who commonly present attention deficits. Nevertheless, young people with attention deficits appear to be capable of sustained interaction with computers, as computerised tasks have been successfully used to facilitate the development of skills in adolescents with special needs (for example Gaylord-Ross, Haring, Breen & Pitts-Conway, 1984; Sedlak, Doyle & Schloss, 1982; Demarest, 2000).

It seems possible therefore, that some aspect of the Computer Choice Task (CCT), used in Experiments 1 to 5 of the present thesis, such as the requirement for participants to interact with a computer, might itself function as a reinforcer for delay; choosing the longer delay had the consequence of more time at the computer, and this might have contributed to greater tolerance of delays than would have been shown in other circumstances. Furthermore, the CCT in Experiment 5 was conducted during school time, raising the question of whether this feature of the experiment might also have had an effect on

adolescents' choices. Specifically, it might be that participants' choices were skewed towards LL rewards as this would prolong time out of class.

The distribution of behaviour between alternatives always occurs in a context. However, the self-control literature reviewed in the current thesis has limited reference to contextual effects. Choice appears almost as an abstract that is independent of context and task. Yet the context in which testing occurs and the nature of the task may be especially important in applied work.

Experiment 6 was designed to explore the effect of different contexts and forms of choice task on the choices made by adolescents with BESD. To determine whether testing during school time influenced choice responding, a comparison was made between performance on the choice task when administered during school and when administered during residential time. To determine whether completing the task on a computer influenced participants' responding, performance on the CCT was compared with that on a functionally equivalent version in which sand-timers replaced the computer. Sand-timers were selected as a means of providing a simple visual presentation of delays.

To clarify, the four conditions of choice task consisted of the Computer Choice Task administered in school during school hours (CCTs), the Computer Choice Task administered in the house outside school hours (CCTh), the Sand-timer Choice Task administered in school during school hours (SCTs) and the Sand-timer Choice Task administered in the house outside school hours (SCTh).

Experiment 6 also provided an opportunity to further explore the relations between other measures of impulsivity and mindfulness. Experiment 5 provided some evidence of a negative relationship between impulsivity (as measured by the Junior I.6) and mindfulness (as measured by the CAMM). These measures were also taken in Experiment 6 in order to assess whether this finding could be replicated.

Another purpose in administering self-report scales was to gauge test-retest reliability. An aim of the present research was to examine whether a mindfulness training intervention might affect impulsive behaviour in adolescents with BESD. In order to achieve this, it was necessary to repeatedly administer the self-report scales at various points in baseline and intervention phases (subsequently reported here as Experiment 7) . According to Duckworth & Seligman (2005), the Junior I.6 subscale had satisfactory (.58) 7 month test-retest reliability. However, no such details have been reported for the CAMM. In the present experiment the test-retest reliability of both the Junior I.6 and the CAMM was examined.

Furthermore, as the Junior I.6 had only satisfactory test-retest reliability over a long period, an additional self-report measure of self-control was administered. This was the Brief Self Control Scale (BSCS: Tangney, Baumeister & Boone, 2004) which has been reported to have a one to three week test-retest reliability of .87 (Tangney et al., 2004) and 7 month test-retest of .76 (Duckworth & Seligman, 2005). Therefore, the BSCS was also evaluated for potential use as a repeated measure. To summarise, Experiment 6 aimed to determine the test-retest reliability of the Junior I.6, the BSCS and the CAMM, and to explore



relations between such self-reports and performance on delay discounting tasks. Additionally, to examine relationships between the delay discounting tasks and other measures of impulsive behaviour (as with Experiment 5), behavioural observations were collected using the Classroom Observation Code (COC; Abikoff & Gittelman, 1985), and ratings of pupils' general impulsive behaviour were obtained from staff.

## **5.2 Method**

### **5.2.1 Participants**

A total of 23 male pupils (between 11 and 19 years of age) with a range of behavioural, emotional, and social difficulties (see Table 5.1) were recruited from the participating school (see section 2.2.1 for details). As testing was to be carried out during both school and residential time, all pupils recruited were required to be enrolled on residential placements at the school. Thirteen had previously participated in Experiment 5 (referred to in the current chapter as the "original participants") and the ten newly recruited participants had not participated in any study within the present project (referred to in the current chapter as the "new participants"). However, during testing one of the original participants (P916) withdrew from the study, and two of the new participants (P2224 and P2222) were removed from the study due to inconsistent class attendance. Given the time delay between the two studies, the original participants' ages (Table 5.1) may have increased.

Table 5.1 *Diagnosis information for all original participants (continued from Experiment 5) and new participants (newly recruited for Experiment 6).*

	P No.	Age (yr)	ADHD	ASD	AS	CD	BESD	S	Tourettes
Original ( <i>n</i> = 13)	P236	16	<b>X</b>				-		
	P13625	15			<b>X</b>		-		
	P116	14		x		<b>X</b>	-		
	P1310	17	<b>X</b>	x			-		
	P1626	17					<b>X</b>		
	P196	17	x	<b>X</b>			-		
	P56	17	<b>X</b>		x		-		
	P1615	19	<b>X</b>		x		-		
	P215	17					<b>X</b>		
	P1926	17					-	<b>X</b>	
	P165	17		<b>X</b>			-		
	P2217	18					<b>X</b>		
	<i>P916</i>	17	<b>X</b>		x		-		
New ( <i>n</i> = 10)	P106	16		<b>X</b>			-		
	P13622	19			<b>X</b>		-		
	P1623	16		<b>X</b>			-		x
	P1911	13					<b>X</b>		
	P1616	16	<b>X</b>	x			-		
	P1417	16	<b>X</b>				-		
	P1317	14		<b>X</b>			-		
	P1622	11	<b>X</b>				-		
	<i>P2224</i>	18		<b>X</b>			-		
	<i>P2222</i>	15	<b>X</b>				-		

*Note: Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Asperger's Syndrome (AS), Conduct Disorder (CD), Schizophrenia (S), Primary diagnosis (X), Secondary diagnosis (x), Associated difficulties (-)*

### 5.2.2 Materials

For all choice tasks the two transparent containers (jam jars: 9cm high by 7cm diameter) described in the general method section 2.2.2 were used. The CCTs and CCTh involved the use of a laptop and a joystick (as described in section 2.2.2). The SCTs and SCTh involved the use of four sand timers (measuring approximately 9cm high by 2cm diameter) with time durations of 30s (seconds), 60s, 90s and 120s (see Figure 5.1). The reliability of each sand timer's duration was tested prior to Experiment 6. The average (mean) durations taken across ten test-retest trials for each sand timer were 29.7s ( $SD = 0.5s$ ) for the 30s timer, 61.1s ( $SD = 1.3s$ ) for the 60s timer, 90.4s ( $SD = 1.8s$ ) for the 90s timer and 119.2s ( $SD = 0.6s$ ) for the 120s timer.



*Figure 5.1* Sand-timers with delays of 30, 60, 90 and 120 seconds as used for the SCTs and SCTh delay discounting measures in Experiment 6.

The SCTs and SCTh also involved the use of a booklet consisting of 12 reward cards (5cm x 5.5cm) ranging from 0p to 10p for SS rewards, and a separate single 10p card for the LL reward. In administering the SCT the researcher used printed sheets stating random right/left side presentation of the SS reward option (to ensure unbiased right/left preference), and a reward flow-chart that specified the reward appropriate at any point according to the Du et al. procedure (see Figure 3.1, section 3.3.3). Scoring sheets for task administration and data collection purposes were used in all choice tasks (those used in Experiment 5). The three questionnaires used were the Junior I.6 Impulsivity Scale (Eysenck, Easting & Pearson, 1984), the Child Acceptance and Mindfulness Measure (CAMM; Greco & Baer, 2005), and the Brief Self Control Scale (BSCS; Tangney, Baumeister & Boone, 2004).

Other materials included an information sheet (Appendix Q), consent forms (see Appendices R and T), instructions, briefing and debriefing documents (see Appendices S and U) and staff general impulsivity rating sheets (see Appendix P and Experiment 5 for further details). Response Times (RTs) were not obtained in Experiment 6 due to the addition of the sand-timer choice task in which such data was difficult to reliably obtain. An MP3 player was used through which an MP3 file was played (that used in Experiment 5) to enable the main experimenter to code behaviours without the need to visually monitor time. Behaviours were coded (see Table 5.3 below) using observation checklists designed for use with the Classroom Observation Code (COC; Abikoff & Gittelman, 1985).

### 5.2.3 Design and Procedure

The 13 adolescents who had previously participated in Experiment 5 had already completed the CCTs (in which three participants had received delays of 30s, 60s and 90s, and ten participants had received delays of 60s, 90s and 120s), the Junior I.6 and the CAMM approximately five months prior to participating in the present study. Therefore, these participants received the additional choice tasks in the following order: CCTh, SCTs, and SCTh. The 10 new participants received choice tasks in accordance with a balanced Latin Square to control for order effects (Table 5.2).

Table 5.2 *The order in which the ten new participants received the four choice tasks.*

Condition Order	Condition Order	Condition Order	Condition Order
1	2	3	4
1 CCTs	2 CCTh	3 SCTs	4 SCTh
2 CCTh	3 SCTs	4 SCTh	1 CCTs
4 SCTh	1 CCTs	2 CCTh	3 SCTs
3 SCTs	4 SCTh	1 CCTs	2 CCTh

The CCT (Computer Choice Task) involved the same procedure and the DAA (R) described in section 3.3.3, with delays of 30 (practice), 60, 90 and 120 seconds presented in ascending order to all participants. Each participant received the CCT during school time in a small room within one of the school units, and during residential time in individual participants' rooms or communal areas within residential units if vacant.

The SCT (Sand timer Choice Task) required participants to sit at a table on which the experimenter placed the single 10p reward card (LL reward), an SS reward card (from the booklet containing SS reward options), a sand timer, and the two transparent containers (one empty, the other containing one penny coins). As for the CCT, the initially empty container was placed nearer to the participant to emphasise that the money accumulated belonged to him (the participant's money pot) and the jar containing the initial 180 one penny coins (the experimenter's money pot) was placed closer to the experimenter to highlight this container belonged to the experimenter.

Furthermore, as in the CCT, the experimenter presented adolescents in the SCT with the initial SS reward value of 5p followed by adjusted SS reward values depending on their previous choice. The LL reward remained at 10p throughout the SCT and sand timer delays were presented in ascending order for all participants and in both house and school contexts. Each choice made was recorded and the monetary reward value chosen was taken from the experimenter's money pot and placed into the adolescent's money pot by the experimenter.

Prior to each testing session the experimenter briefed and read instructions to participants to remind them of experiment details and each participant was required to sign a consent form. On completion of the final session, the experimenter debriefed each participant and money rewarded to participants was given to a previously designated member of staff at the school or the participant's key worker.

Testing sessions involving the administration of choice tasks and questionnaires lasted between 20 and 45 minutes depending on the length of delay the boys chose to wait. Sessions during school time were conducted in a number of small quiet rooms throughout the school, at various times throughout the school day and during various lessons, to limit disruption to pupils' education and timetables. During residential time the choice task and questionnaire testing sessions were conducted during the weekend and after school in house lounges (when quiet) or in adolescents' individual rooms. Throughout testing the experimenter possessed a radio at all times and individual room doors remained open. The experimenter was familiar with the young males and had received training and undergone relevant checks to enable one-to-one sessions to occur.

Due to similarities between items in the Junior I.6 and the BSCS these scales were administered in alternate testing sessions to reduce the possibility of response matching. All participants were asked to complete the Junior I.6 following their first choice task, the CAMM following their second choice task, and the BSCS on completion of their third choice task. The new participants therefore, did not receive a questionnaire in their final testing session.

To obtain a subjective measure of impulsivity, therapy and teaching staff at the school were asked to rate pupils' general impulsivity in school on a 1 (never) to 10 (always) point scale (see Experiment 5 for further details). In addition, behavioural observations using the Classroom Observation Code (COC: Abikoff & Gittelman, 1985) were conducted weekly on each pupil, with the exception of

a few instances where participants were not in school or refused to attend lessons. Seventy percent of observations occurred during English lessons as 60 percent of pupils were taught by one particular English teacher. The remaining 40 percent were taught English by their main class teacher. Twenty-five percent of lessons observed were Physical, Social, Health and Economic education (PSHE) and 5 percent of lessons observed were science lessons. Due to the difficulties presented by the pupils at the school, class sizes ranged from two to six pupils and observations were carried out between the school hours of 09:15 and 15:15.

The COC was previously used in Experiment 5, however in accordance with Solanto et al. (2001), only a selection of behaviours that corresponded with the core symptoms of ADHD were coded. These included: Interference, Solicitation, Aggression, Off-task, Gross Motor-Standing and Gross Motor-Vigorous. The following behaviours were not recorded: Out-of-Chair behaviour, Minor Motor Movements, and Non-Compliance. However, these were re-included in the observation code used in Experiment 6 as it could be argued that these are forms of impulsive behaviour (see chapter 6 for further discussion). Each classroom observation was divided into sixty-four 15 second intervals in which all 12 behaviours were coded (see Table 5.3 below). To assist analysis of classroom observations in the present experiment behaviours were grouped to produce composite measures of behaviours (outlined in Table 5.3) in accordance with suggestions made by Solanto et al., (2001). All observations were conducted by the experimenter, and generally lasted 16 minutes.



Table 5.3 *Behaviours, codes, and composite measures for classroom observations (COC).*

<b>Behaviour and Code</b>	<b>Composite Measure</b>
Interference ( <i>I</i> )	Impulsive Behaviours
Solicitation of Teacher ( <i>S</i> )	
Off-Task ( <i>X</i> )	Inattentive Behaviours
Non-Compliance ( <i>NC</i> )	
Extended Out-of-Chair Behaviour ( <i>OC</i> )	
Gross Motor Standing ( <i>GMs</i> ),	Hyperactive Behaviours
Gross Motor Vigorous ( <i>GMv</i> )	
Minor Motor Movement ( <i>MM</i> )	
Physical Aggression ( <i>A</i> )	Aggressive Behaviours
Threat/Verbal Aggression to Children ( <i>AC</i> )	
Threat/Verbal Aggression to Teacher ( <i>AT</i> )	
Absence of Behaviour ( <i>AB</i> )	

In addition, as part of the schools monitoring system, attendance to lessons was recorded by staff and collated at the end of each day to maintain records of pupils' progress. Pupils were rated by the teacher after each lesson on their attendance to the lesson. These data were obtained from the school and provided an additional measure of behaviour, adding to that provided by the classroom observations obtained using the COC.

### 5.3 Results

Three participants (P916, P2224 and P2222) were removed from the study (see section 5.2.1 for details). Therefore, a total of 20 participants completed all choice tasks, questionnaires, and classroom observations. In addition, four members of staff completed impulsivity ratings for pupils whom they had frequent contact with during school and residential periods. Indifference points (IP) were calculated for each choice task, across each delay for each participant. Mean IP's were calculated across the 60s, 90s and 120 second delays obtained by each participant in each choice task (as the 30 second delay was a practice task in which no monetary rewards were delivered, it was excluded in the mean IP value). Because data for the CCTs at the 120s delay were absent for two participants (P236 and P13625), their mean IPs were calculated for the 60s and 90s delays only.

To explore the extent to which method, location, delay and condition order affected participants' discounting in the choice task, a four-way mixed ANOVA was conducted for within subjects factors of Method (Computer and Sand Timer), Location (School and House), and Delay (60s, 90s and 120s) and a between factor of Condition Order (COrder). As P236 and P13625 had received delays of 60 and 90 as the third and last delay condition in the CCT, it was possible that this effected IPs and they were removed from the ANOVA (therefore,  $n = 18$ ). Tests for normality (given the relatively small sample size it was deemed most appropriate to use Shapiro-Wilk) revealed that the distributions of IP data (for each choice task and at each delay) significantly deviated from a normal distribution (e.g., CCTs at the 120s delay:  $D(18) = .87$ ,  $p = .02$ ; CCTh at the 90s delay:  $D(20) = .78$ ,  $p < .01$ ; SCTs at the 60s delay:

$D(20) = .81, p < .01$ ; SCTh at the 120s delay:  $D(20) = .75, p < .01$ ). Therefore, to compensate in order to reduce the possibility of making a type 1 error, the level of significance was reduced to  $p < .02$ .

The results showed that the main effect of Method was not statistically significant, but there was a significant main effect of Delay. There was a two-way interaction between Method and Location, and there was a statistically significant three-way interaction between Method, Location and Condition Order (Table 5.4).

However, there were no other significant main effects or interactions (including no main effect of Condition Order and no main effect of Location) on participants' IPs (Table 5.4). However, it is important to note that the two new participants removed from Experiment 6 during initial testing were intended to receive choice tasks according to condition order 2 (see Table 5.2 in the present chapter), leaving P1417 as the only participant to have received choice tasks in accordance with Condition Order 2. In addition, since the original participants had received the CCTs approximately 5 months before the CCTh, SCTs and SCTh, it could be argued that conditions were not counterbalanced correctly. Therefore, it is necessary to be cautious with regards to reaching conclusions about condition order effects.

Table 5.4 Results from the four-way mixed ANOVA in Experiment 6.

Variable	<i>df</i>	<i>F</i>	$\eta^2$	<i>p</i>
Method	1(13)	6.31	.33	.03
Method*Condition order	4(13)	.48	.13	.75
Location	1(13)	1.84	.12	.2
Location*Condition order	4(13)	1.12	.26	.39
Delay	2(26)	20.11	.61	<.01 <sup>Δ</sup>
Delay*Condition order	8(26)	2.72	.47	.03
Method*Location	1(13)	16.36	.56	<.01 <sup>Δ</sup>
Method*Location*Condition order	4(13)	4.46	.58	.02 <sup>Δ</sup>
Method*Delay	2(26)	.66	.05	.52
Method*Delay*Condition order	8(26)	1.09	.25	.40
Location*Delay	2(26)	2	.13	.16
Location*Delay*Condition order	8(26)	1.55	.32	.19
Method*Location*Delay <sup>†</sup>	1.2(26)	2.74	.17	.11
Method*Location*Delay*Condition order	8(26)	1.33	.29	.27
Condition order	4(13)	1.17	.26	.37

Note: <sup>Δ</sup>Significant at the  $p < .02$  level. <sup>†</sup>Greenhouse-Geisser adjustment.

Figure 5.2 illustrates a larger difference between the mean IPs obtained for each choice task method, especially for the 90s delay, than the difference between mean IPs produced for each location, highlighting the moderate (but not statistically significant) main effect of Method, but not Location. Figure 5.2 shows a moderate difference between IPs obtained in the two location conditions at the 60s delay, with higher mean IPs obtained during testing in school. The 90s and 120s delays produced similar mean IPs in the 2 location

conditions, possibly influencing the finding of no significant effect of Location. The CCT generally produced larger mean IPs than the SCT, however, both were affected by increased delays in a similar pattern. As characteristic of delay discounting tasks, the mean IPs decreased as the delay to the LL reward was systematically increased from 60 to 90 seconds and from 90 to 120 seconds. This significant main effect of delay provides further evidence that the choice tasks designed in the present thesis for use with adolescents with behavioural, emotional and social difficulties (BESD) generally produced discounting behaviour typically observed in delay discounting procedures.

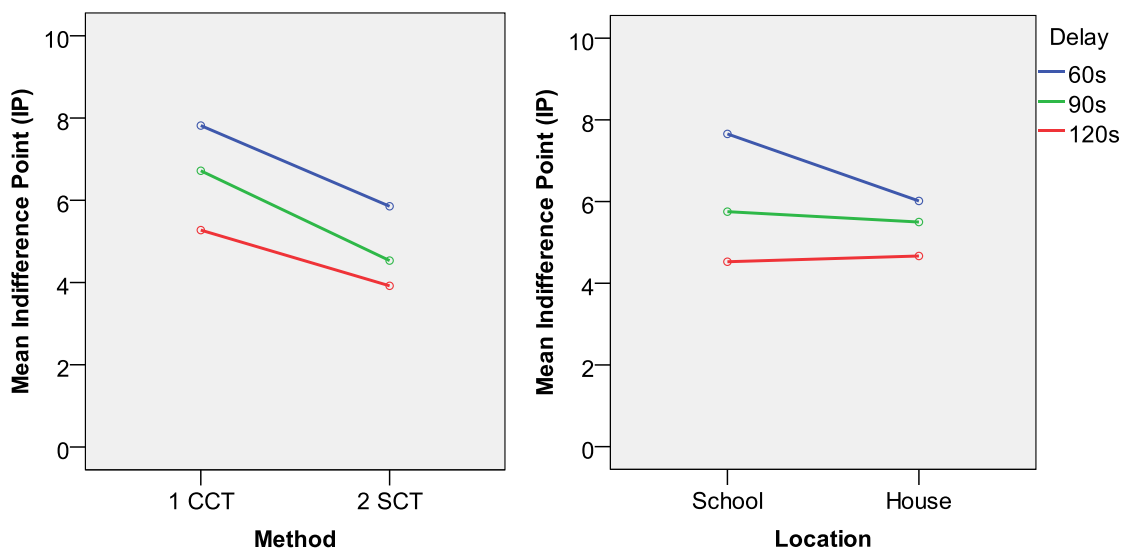


Figure 5.2 Mean indifference points produced by each method and location condition across the three delays of 60, 90 and 120 seconds (s).

As can be seen in Figure 5.3, the significant interaction between Method (Computer and Sand timer) and Location (School and House) indicates that participants ( $n = 18$ ) generally made more impulsive choices in the SCT and more self-controlled choices in the CCT. There was a larger effect of location on SCT than the CCT and an effect of method in the house, but a very slight

effect of method in school. The interaction means show participants were more self-controlled on the CCT in the house and more self-controlled on the SCT in school. This is clearly because task type made little difference in school, but a much larger difference between tasks at home.

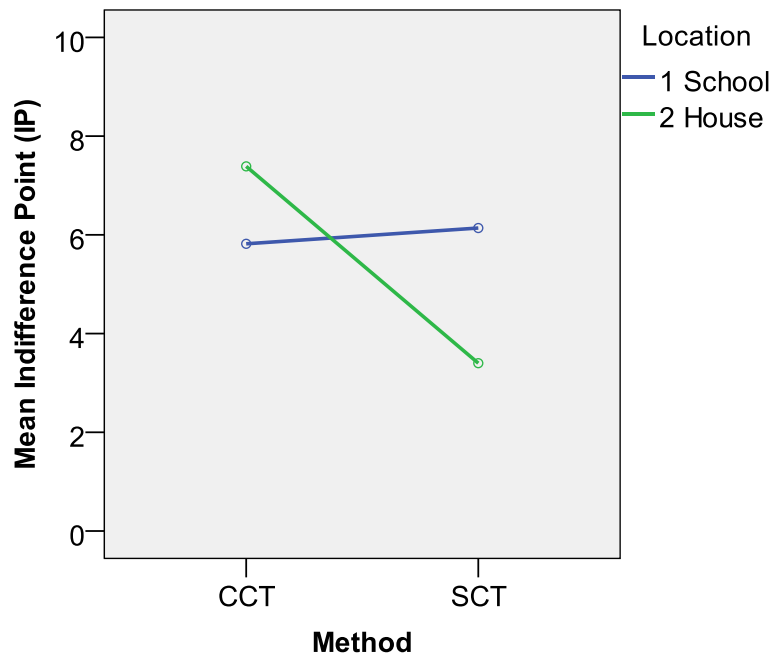


Figure 5.3 Plot of the significant interaction between Method and Location conditions.

Delay had a statistically significant effect on IP and Figure 5.4 shows that the mean IPs for all choice tasks at each delay decreased as delays increased. This is typical of responding produced by discounting tasks and suggests the choice tasks were effective in measuring delay discounting in adolescents with BESD. In support of this, planned comparisons for delay revealed a statistically significant difference between mean IPs at the 60s and 90s delays:  $F(1,13) = 10.07, p < .01, \text{partial } \eta^2 = .44$ ; and between mean IPs at the 90s and 120s delays:  $F(1,13) = 14.34, p < .01, \text{partial } \eta^2 = .52$ .

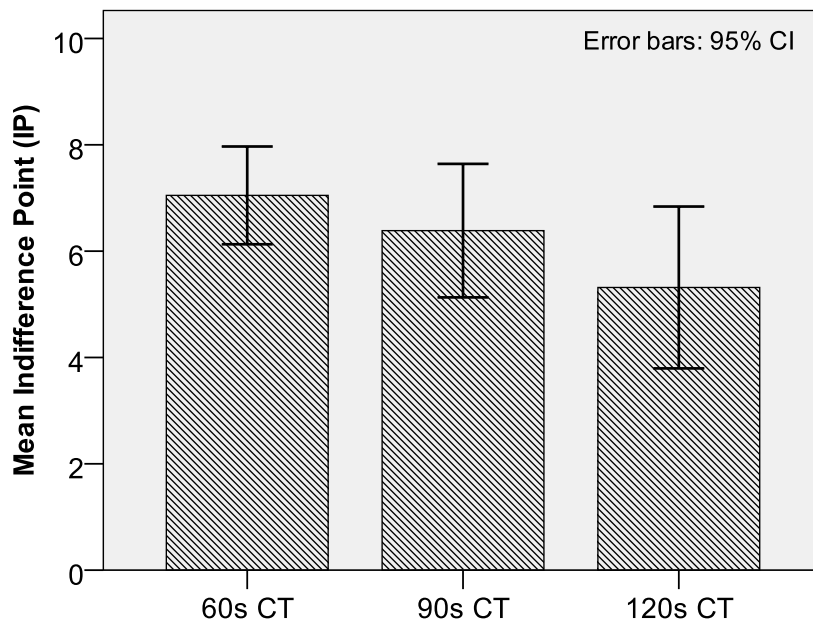


Figure 5.4 Mean Indifference Points (IPs) and associated error bars (95 percent confidence interval) across the main delays for all of the choice tasks (CT) and all participants (60s CT:  $n = 20$ ; 90s CT:  $n = 20$ , 120s CT:  $n = 18$ ).

Figure 5.5 shows each individual's choice responding across the three delays in the different choice tasks in the order they were administered. From left to right, P236 to P1626 were the original participants whom had received the CCTs previously in Experiment 5. P1317 to P1622 were the newly recruited participants who received the choice tasks in accordance with the balanced Latin square order.

As can be seen in Figure 5.5, choice responding varied greatly between participants indicating large individual differences in delay tolerance. Figure 5.5 shows that four of the original participants (P215, P165, P1926 and P2217) and two of the new participants (P1623 and P1417) increased their rate of discounting, hence were less delay tolerant and made more impulsive choices,

as the number of choice tasks they received increased. However, the remaining seventy percent of participants either maintained a similar tolerance across all delays within and between each choice task (e.g., P196) or increased their tolerance of delays between each choice task (e.g., P1615). Therefore, it appeared that no consistent pattern existed across participants and consequently, supporting findings from the mixed ANOVA, it seems reasonable to argue that there was no specific order effect on IPs.



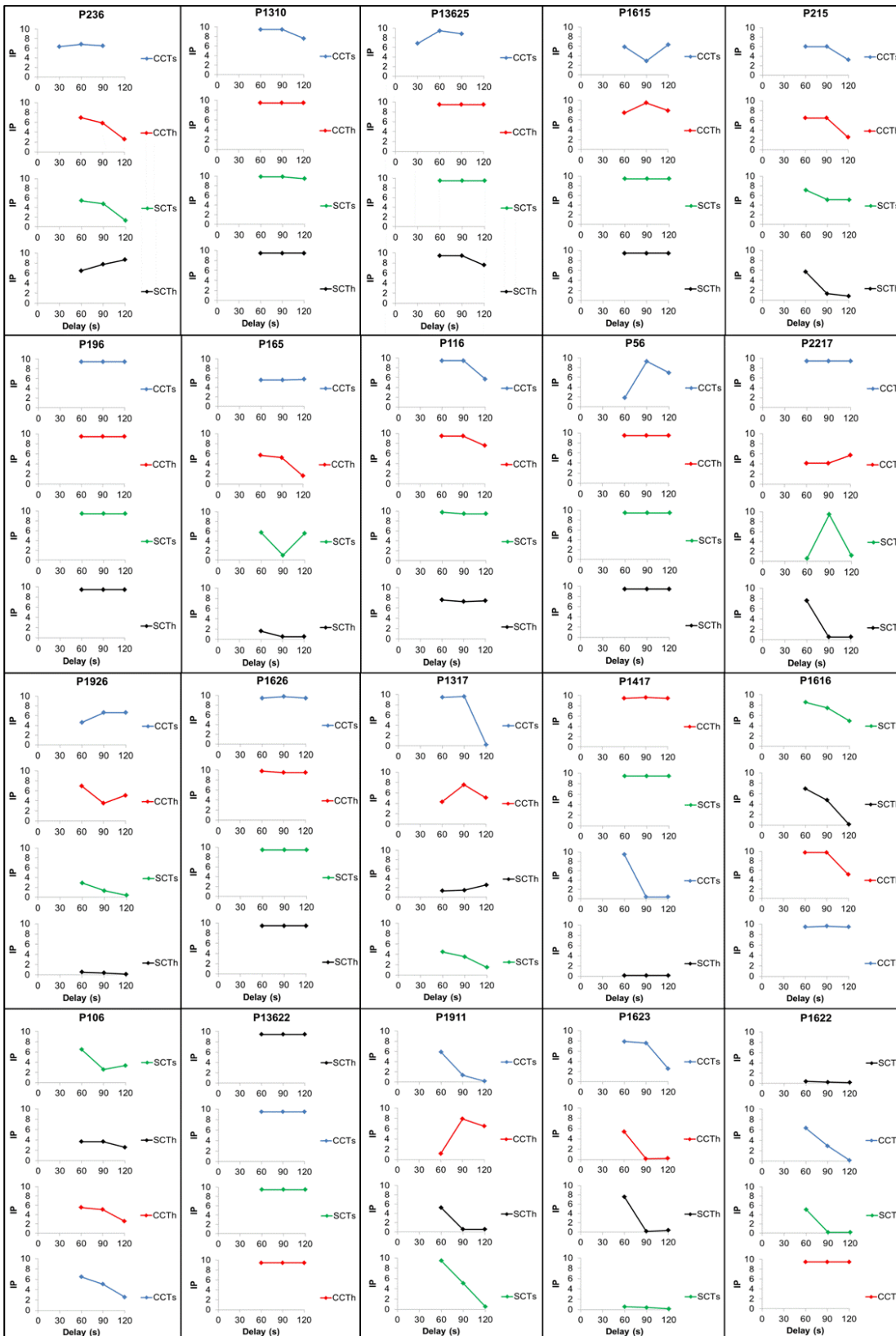


Figure 5.5 Each participant's indifference points (IP) obtained in each choice task across all main delays (30, 60 and 90 seconds  $n = 2$ ; 60, 90 and 120 seconds  $n = 18$ ) in the order in which they were received.

Of the total 20 participants, 13 participants made most self-controlled choices in the CCT, four participants made most self-controlled choices in the SCT and three participants chose similarly in the two choice task methods. Figure 5.6 below indicates that, although mean IPs for the new participants were consistently lower than those obtained for the original participants, mean IPs obtained in each of the four choice tasks followed a similar pattern for both original and newly recruited participants, with the exception of the CCTh for the new participants. However, IP data across the choice tasks for the new participants appear to have decreased more rapidly than for the original participants. In accordance with findings revealed by the ANOVA, Figure 5.6 shows that the sand timer (SCT) produced lower mean IPs (more impulsive choices), especially in the house (h) location condition, with the computer (CCT) producing higher mean IPs (more self-controlled choices).

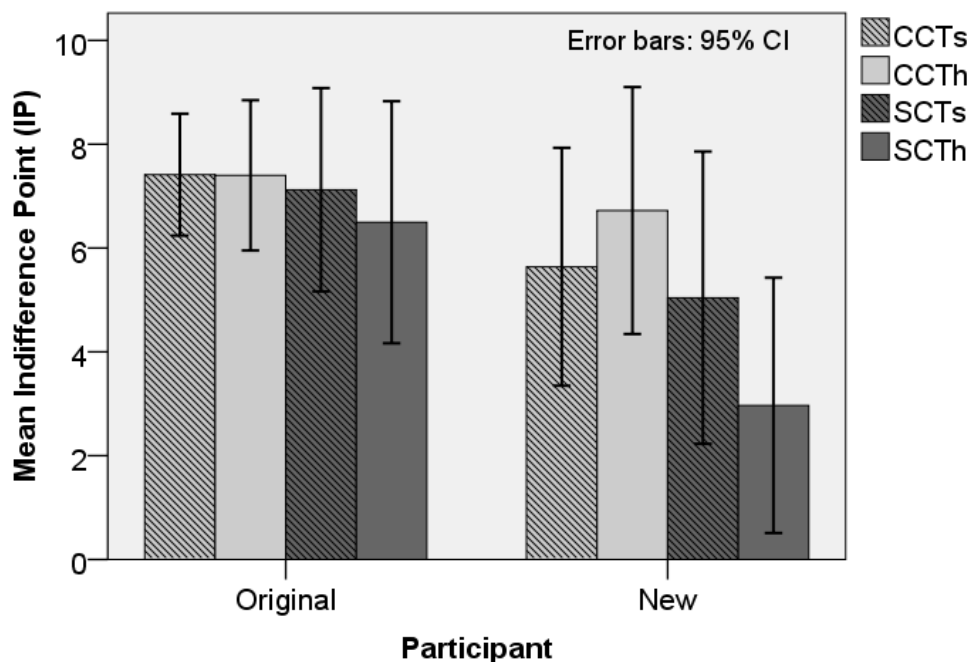


Figure 5.6 Mean Indifference points (IP) and associated error bars (95 percent confidence interval) obtained in each choice task for original ( $n = 12$ ) and new ( $n = 8$ ) participants.

Of the total 20 participants, ten made more self-controlled choices when the choice task was carried out in school, six made more self-controlled choices in tasks in the house and four participants presented similar choice responding in both school and house location conditions. Mean IPs were calculated for each choice task method and location and reproduced in Figure 5.7. In support of findings revealed by the ANOVA and those displayed in Figure 5.6, Figure 5.7 indicates that the computer produced a higher mean IP (more self-controlled responding) than the sand timer. However the mean IPs obtained in each location condition were similar, with school producing slightly higher mean IPs than in the house.

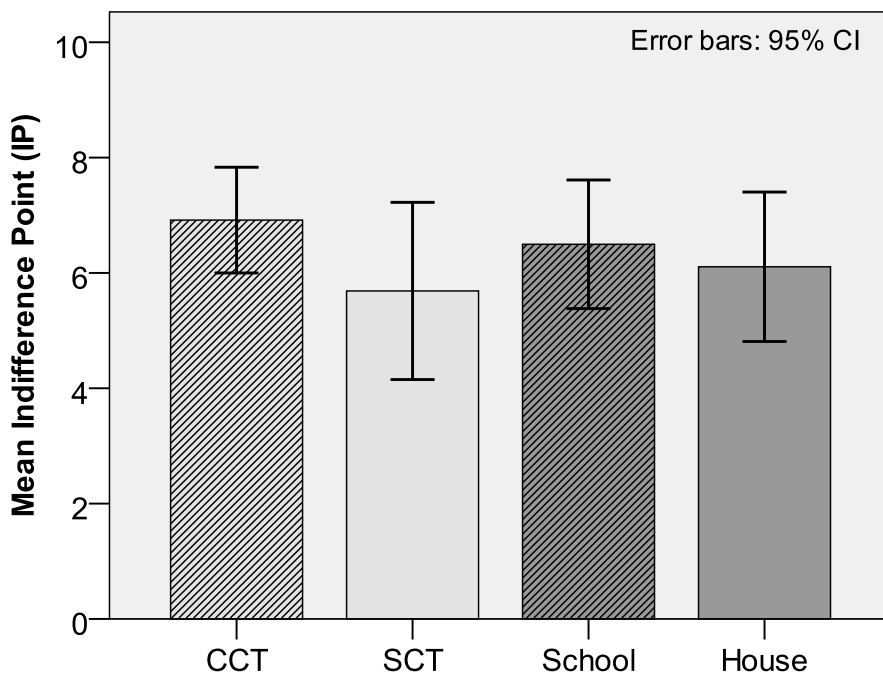


Figure 5.7 Mean indifference points (IP) and associated error bars (95 percent confidence interval) for each method and location across all participants ( $n = 20$ ).

One explanation for the SCT producing the most impulsive choice responding could be order effects. As the twelve original participants received choice tasks in the same order (CCTs, CCTh, SCTs and SCTh) and the eight newly recruited participants received choice tasks in different orders, mean indifference points (IP) were calculated for the positions in which each choice task was administered. Figure 5.8 suggests a possible order effect on participants' choice responding, as the original participants presented a very slight increase in impulsivity as they were presented with more choice tasks. The new participants similarly increased discounting (chose more impulsively) across the first three choice tasks, however they presented increased self-control in the final choice task administered.

Although Figure 5.6 provided evidence to suggest that the original participants generally chose more impulsively in the SCTh, it is possible that such responding was due to an order affect as the SCTh was the last choice task presented to them. However, the eight newly recruited participants received the choice tasks in accordance with a balanced Latin Square and similarly produced the lowest mean IP in the SCTh (Figure 5.6) but increased their tolerance of delays in the final choice task they received (Figure 5.8). It seems that there was a slight effect of condition order on IPs with both original and new participants producing lower IPs as the number of choice tasks (CT) they were presented with increased, with the exception of choice task 4 in which new participants produced a larger mean IP. Figure 5.8 indicates that IPs produced by the new participants decreased more rapidly than for the original participants.

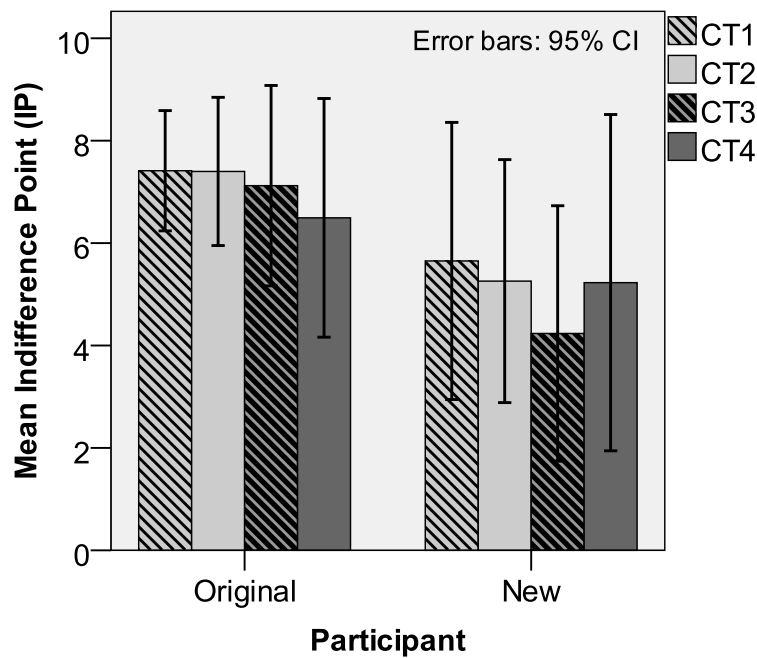


Figure 5.8 Mean indifference points (IP) and associated error bars (at the 95 percent confidence interval) in order of choice task presentation for original ( $n = 12$ ) and new participants ( $n = 8$ ).

If an effect of condition order was present, one would expect mean IPs (across the three delays) to decrease with increased presentation of choice tasks. However, when mean IPs were compared for each choice task (CT) at each position (1, 2, 3 and 4) the CTs were presented in (Figure 5.9), IPs appear varied throughout. This suggests no systematic effect of condition order on IPs. The only exception was a slight decrease in mean IP in the SCTs when it was the last choice task received and smaller IPs in the SCTh across CT positions 2 and 3. It is difficult however, to derive firm conclusions due to the small participant numbers and the incomplete counterbalancing.

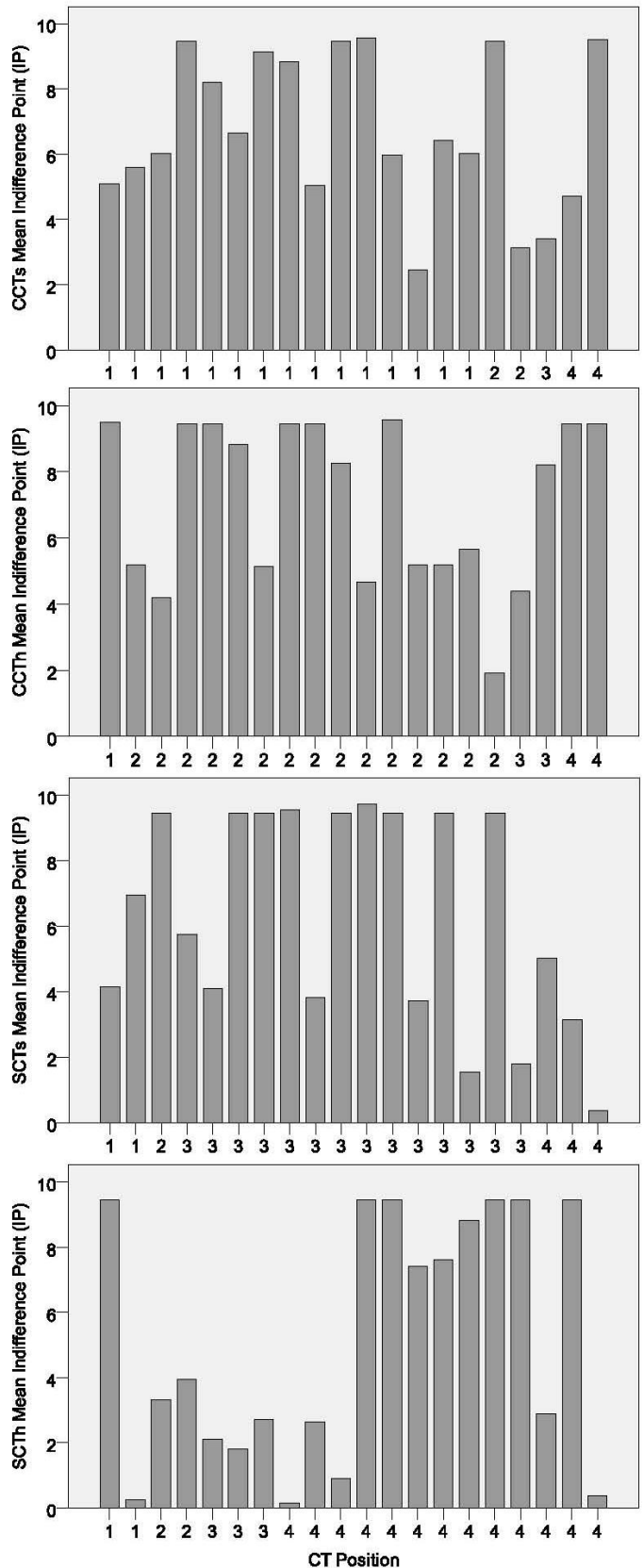


Figure 5.9 Mean indifference points (IP) obtained for each choice task (CCTs, CCTh, SCTs and SCTh) at each position (1, 2, 3 or 4) in which they were presented ( $n = 20$ ).

When mean IPs for both new and original participants were collated (Figure 5.10), a very slight but trivial effect of condition order on IP was apparent.

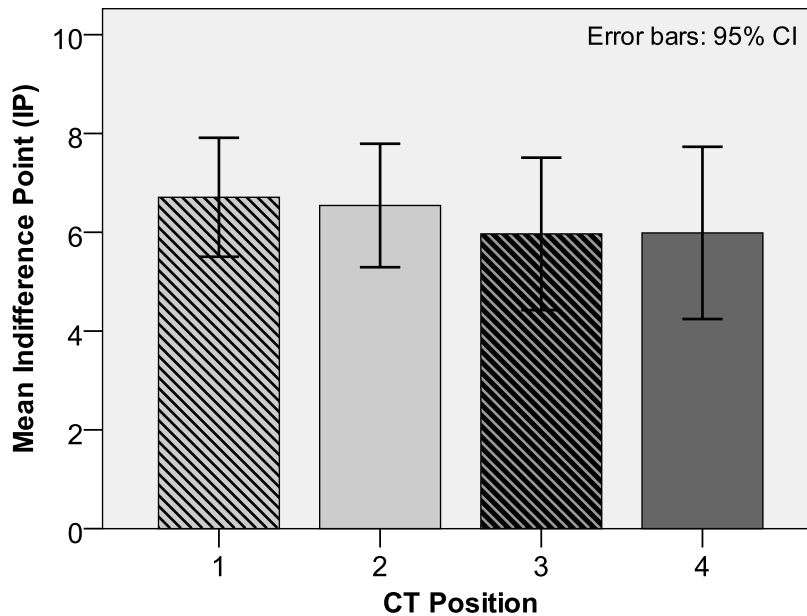


Figure 5.10 Mean indifference points (IP) and associated error bars (at the 95 percent confidence interval) in order of choice task presentation for all participants ( $n = 20$ ).

To explore relationships within and between the different impulsivity and mindfulness measures, correlational analysis was performed on the mean indifference points obtained for each choice task, percentage scores obtained on self-report measures (Junior I.6, CAMM and BSCS), staff ratings (obtained from four members of staff), the percentage of behaviour recorded using the COC (divided into the four composite measures and the total percentage of behaviours presented), and the percentage of full class attendance. Several significant correlations were found both within (Tables 5.5 to 5.7 below) and between (Tables 5.8 to 5.11) measures.

Given the significantly non normal distribution of IP data described earlier, correlations involving IP data were performed using Spearman's rho. As can be seen in Table 5.5 there were strong positive correlations between the mean IPs obtained on the Computer Choice Task administered during school time (CCTs) and the Sand Timer Choice Task administered in the house (SCTh) and school (SCTs). Significant correlations were also found between mean IPs obtained on the Computer Choice Task in the house (CCTh) and the Sand Timer Choice Task in school (SCTs) and between the mean IPs obtained in the Sand Timer Choice Task in school (SCTs) and the Sand Timer Choice Task in the house (SCTh). However, there was no correlation between mean IP's produced by the Computer Choice Task administered in school (CCTs) and the Computer Choice Task administered in the house (CCTh) or between the Computer Choice Task in school (CCTs) and the Sand Timer Choice Task in the house school (SCTh).

Table 5.5 *Spearman's rho correlations between the mean Indifference Points obtained on choice tasks.*

Measure 1	Measure 2	$r_s$	$p$	$n$
CCTs	CCTh	.27	.25	20
CCTs	SCTs	.33	<.01**	20
CCTs	SCTh	.31	<.01**	20
CCTh	SCTh	.38	.1	20
CCTh	SCTs	.69	<.01**	20
SCTs	SCTh	.66	<.01**	20

Note: \*\* Correlation is significant at the  $p < .01$  level (two-tailed).



To determine the test-retest reliability of the self report scales, Junior I.6 and CAMM scores previously obtained by the 12 original participants (Experiment 5) were compared to their scores in the current study. Distributions of data from the self-report scales were normal (according to Shapiro-Wilk normality tests) therefore, within measure correlations were performed using Pearson's correlation coefficient. The coefficients in Table 5.6 show a positive relationship between scores obtained on the Junior I.6 in Experiment 5 and those obtained in Experiment 6, providing evidence to suggest satisfactory (.63) 5 month test-retest reliability of the Junior I.6. However, no significant correlation was evident between scores obtained from the CAMM in Experiment 5 and the CAMM in the current study.

As reported in Experiment 5, there was a significant negative correlation between scores obtained on the CAMM (1) and the Junior I.6 (1). In addition, Table 5.6 illustrates a moderate negative correlation was found between the CAMM (1) and the Junior I.6 (2) providing evidence in support of a relation between high impulsivity and low mindfulness. However, there was no correlation between scores obtained on the Junior I.6 and the CAMM in the present experiment. Although the BSCS and CAMM (1 and 2) were not correlated, data from Table 5.6 show a negative correlation between the newly administered BSCS and the Junior I.6 (1 and 2) indicating that individuals obtaining low self-control scores on the BSCS attained high impulsivity scores on the Junior I.6.

Table 5.6 *Pearson's Correlation Coefficients for the self-report scales from (1) Experiment 5 (12 original participants) and (2) Experiment 6 (original and new participants, n = 20).*

Measure 1	Measure 2	<i>r</i>	<i>p</i>	<i>n</i>
CAMM (1)	CAMM (2)	.07	.84	12
Junior I.6 (1)	Junior I.6 (2)	.63	.03*	12
Junior I.6 (1)	CAMM (1)	-.75	<.01**	12
Junior I.6 (1)	CAMM (2)	.05	.89	12
Junior I.6 (2)	CAMM (1)	-.64	.03*	12
Junior I.6 (2)	CAMM (2)	-.39	.09	20
Junior I.6 (1)	BSCS	-.63	.03*	12
Junior I.6 (2)	BSCS	-.75	<.01**	20
CAMM (1)	BSCS	.52	.08	12
CAMM (2)	BSCS	.21	.38	20

*Note:* \*Correlation is significant at the  $p < .05$  level, \*\* Correlation is significant at the  $p < .01$  level (two-tailed).

Ratings of pupils' general impulsivity were obtained from four different members of education and therapy staff (referred to anonymously as S1, S2, S3 and S4). Distributions of data (tested using Shapiro-Wilk) from Staff Impulsivity Ratings (SIR) revealed data to be normally distributed, therefore correlations between SIR data were performed using Pearson's Correlational analysis. Staff only rated pupils whom they were most familiar with and therefore correlations between S1 and S2, and between S1 and S4 were unattainable due to limited data. All other possible correlations (see Table 5.7) revealed that general impulsivity ratings by staff were relatively highly correlated.

Table 5.7 *Pearson's Correlation coefficients for staff ratings of participants' general impulsivity.*

Measure 1	Measure 2	<i>r</i>	<i>p</i>	<i>n</i>
S1	S3	.94	<.01**	7
S2	S3	.70	.02*	11
S2	S4	.77	.02*	9
S3	S4	.68	.01**	13

Note: \*Correlation is significant at the  $p < .05$  level, \*\* Correlation is significant at the  $p < .01$  level (two-tailed).

Tests for normality (using Shapiro-Wilk) revealed distributions for observation (COC) data significantly deviated from the normal distribution. As a result, to explore correlations between data, a Spearman's Correlational analysis was carried out. Significant positive correlations were found between the percentage of inattentive behaviour observed in the classroom and the percentage of aggressive behaviour observed in the classroom ( $r^s = 0.61$ ,  $p < .01$ ,  $n = 20$ ) and the percentage of impulsive behaviour observed in the classroom ( $r^s = .5$ ,  $p = .03$ ,  $n = 20$ ). This suggested that participants who presented highly inattentive behaviours in the classroom also presented aggressive behaviour and impulsive behaviour more frequently. However, no other correlations were identified between the four behaviour constructs (Impulsive behaviour, Inattentive behaviour, Hyperactive behaviour and Aggressive behaviour) in the COC.

Table 5.8 shows the few significant positive correlations found between percentage scores on the self-report measures and the mean Indifference Points (IP) on the choice tasks. As mentioned previously, IP data were significantly deviated from a normal distribution, and therefore Spearman's rho was used to determine between measure correlations. Scores on CAMM (1) correlated with the Computer Choice Task in school (CCTs), CAMM (2) correlated with the Sand timer Choice Task in school (SCTs), and the BSCS correlated with the Computer Choice Task in school (CCTs). This suggests participants scoring high mindfulness (CAMM) and self-control (BSCS) were more tolerant of delays in some choice tasks (predominantly the CCTs). However, there were no significant correlations between the CAMM and CCTh or SCTh, between the BSCS and CCTh, SCTs or SCTh, and between the Junior I.6 and choice tasks.

Table 5.8 *Spearman's rho Correlation coefficients of percentage scores on self-reports and mean Indifference Points from choice tasks.*

Measure 1	Measure 2	$r_s$	$p$	$n$
CAMM (1)	CCTs	.62	.03*	12
CAMM (2)	SCTs	.48	.03*	20
BSCS	CCTs	.49	.03*	20

*Note:* \*Correlation is significant at the  $p < .05$  level (two-tailed). (1) Experiment 5 original participants  $n = 12$ , (2) Experiment 6 original and new participants  $n = 20$ .

In addition to IP data and observation data, distributions of class attendance data were found to be deviated significantly from the normal distribution (using

Shapiro-Wilk). As a result, Spearman's rho was carried out to explore between measure correlations between self-reports, behavioural observations, class attendance and staff impulsivity ratings (Table 5.9). The Junior I.6 (2) was significantly correlated with aggressive behaviour, inattentive behaviour and ratings from staff member 1, indicating that the more impulsive pupils rated themselves to be the more aggressive and inattentive their behaviour was observed to be and the more impulsive S1 rated them to be.

Table 5.9 shows that the percentage of full attendance in class was positively correlated with CAMM (1) indicating that participants with higher mindfulness had higher class attendance, however this was not correlated with CAMM (2). Scores on CAMM (2) correlated negatively with inattentive behaviour (recorded on the COC) and was closely (but not significantly) correlated with the staff impulsivity rating from S4. Similarly, the BSCS was negatively correlated with the total percentage of undesirable behaviour the percentage of inattentive behaviour and the staff impulsivity rating from S1. Furthermore, although not significant, the BSCS was closely correlated with the percentage of hyperactive behaviour observed in the classroom. This shows that participants with lower mindfulness scores (CAMM) and lower self-control scores (BSCS) presented more undesirable target behaviour in the classroom and were rated as more impulsive by two of the members of staff.

However, CAMM (1) did not correlate with, observed behaviour (COC) or staff ratings, the BSCS did not correlate with class attendance, and the Junior I.6 did not correlate with class attendance. Table 5.9 shows a selection of correlations.

All other correlations analysed between self-reports and other measures not already presented here were not significant.

Table 5.9 Spearman's rho correlation coefficients for self-report scales, classroom behaviour, staff impulsivity ratings and class attendance.

Measure 1	Measure 2	$r_s$	$p$	$n$
Junior I.6 (2)	Aggressive Behaviour	.45	.05*	20
Junior I.6 (2)	Inattentive Behaviour	.47	.04*	20
Junior I.6 (2)	S1	.78	.04*	7
CAMM (1)	Class Attendance	.66	.02*	12
CAMM (2)	Class Attendance	.16	.51	20
CAMM (2)	Inattentive Behaviour	-.53	.02*	20
CAMM (2)	S4	-.52	.07	13
BSCS	Inattentive Behaviour	-.47	.04*	20
BSCS	Hyperactive Behaviour	-.44	.05	20
BSCS	Total Behaviour	-.59	<.01**	20
BSCS	S1	-.95	<.01**	7

Note: \*Correlation is significant at the  $p < .05$  level, \*\* Correlation is significant at the  $p < .01$  level (two-tailed). (1) Experiment 5 original participants  $n = 12$ , (2) Experiment 6 original and new participants  $n = 20$ .

As can be seen from Table 5.10, there were a number of negative correlations between data obtained from classroom observations and mean IPs obtained in the choice tasks (CT), providing evidence that participants who presented more undesirable classroom behaviour were less delay tolerant (more impulsive) in the choice tasks. It is important to note again that because both IP and

observation data deviated significantly from the normal distribution, correlations were explored using Spearman's rho. However, no statistically significant correlations were found for the composite measures of impulsive behaviour or aggressive behaviour and the CCTs and mean CT were the only choice tasks significantly correlated with the percentage of total behaviour observed (Table 5.10). All other correlations between behavioural observations and choice tasks were not significant.

Table 5.10 *Spearman's rho correlations between behaviour observations (COC) and choice tasks.*

Measure 1	Measure 2	$r_s$	$p$	$n$
Total Behaviour	CCTs	-.46	.04*	20
Total Behaviour	CCTh	-.41	.07	20
Total Behaviour	SCTs	-.3	.2	20
Total Behaviour	SCTh	-.44	.05	20
Total Behaviour	Mean CT	-.47	.04*	20
Inattentive Behaviour	CCTh	-.47	.04*	20
Inattentive Behaviour	SCTs	-.39	.09	20
Inattentive Behaviour	Mean CT	-.4	.08	20
Hyperactive Behaviour	SCTh	-.46	.04*	20

Note: \*Correlation is significant at the  $p < .05$  level.

Spearman's rho correlational analysis was performed to determine whether the observation data correlated with the SIR (staff ratings) because data were non normally distributed. Staff ratings from three members of staff (S1, S2 and S3) on participants' general impulsivity were positively correlated with aggressive

behaviour observed in the classroom (COC). In addition, the percentage of inattentive behaviour observed was significantly correlated with ratings from S3 (Table 5.11). Therefore, such correlations indicated partial consistency between ratings and behavioural observations. However, all other correlations between observed behaviour and staff ratings were not significant.

Table 5.11 *Spearman's rho correlation coefficients between behaviour observed in the classroom and staff ratings of participants' general impulsivity.*

Measure 1	Measure 2	$r_s$	$p$	$n$
Inattentive Behaviour	S1	.71	.07	7
Inattentive Behaviour	S2	.57	.07	11
Inattentive Behaviour	S3	.55	.01*	20
Aggressive Behaviour	S1	.84	.02*	7
Aggressive Behaviour	S2	.63	.04*	11
Aggressive Behaviour	S3	.64	<.01**	20
Total Behaviour	S1	.71	.07	7

*Note:* \*Correlation is significant at the  $p < .05$  level, \*\* Correlation is significant at the  $p < .01$  level (two-tailed).

## 5.4 Discussion

The ANOVA revealed a significant main effect of delay, an interaction between method and location (school versus house) and an interaction between method, location and condition order. There was no significant effect of method (Computer versus Sand timer) on IPs and no significant main effects of location or condition order. However, there was an issue with the condition order as two



of the new adolescents in one condition order group were removed. Furthermore, the 12 adolescents who received the choice tasks in a fixed order had received the first task 5 months prior to the remaining tasks. Therefore, it is possible to maintain that condition order was incompletely counterbalanced between participants and it was necessary that subsequent analysis of condition order effects take this issue into consideration.

Adolescents were most impulsive in the SCT<sub>H</sub>, least impulsive in the CCT<sub>H</sub>. There was no significant difference in mean IPs between the computer and sand timer in school, but a large difference between the computer and sand timer in the house. For both the computer and sand timer, and both in the house and at school, IPs decreased as delays increased. In addition to the significant main effect of delay, such patterns are typical of discounting tasks, suggesting the CCT and SCT were effective in measuring delay discounting in adolescents with BESD.

Although the choice tasks produced typical discounting behaviour overall, indifference curves varied greatly between adolescents. Observations of individual data (Figure 5.5 and Figure 5.9) appeared to reveal no obvious effect of condition order such as fatigue effects (i.e., repeated administration of similar tasks might have resulted in steeper discounting (smaller IPs) as the number of choice tasks increased). Mean IPs for the original adolescents slightly decreased with increased presentation of choice trials, with the exception of the first two tasks (CCT) where mean IP remained the same (Figure 5.8). It is possible that this might have been due to the large time delay (5 months) between the two testing sessions. It is likely that this compromised accurate

counterbalancing of condition order, however as a result, it seems reasonable to suggest that the choice task has good test-retest reliability over 5 months.

Mean IPs for the newly recruited adolescents decreased across the first three tasks, but increased in the final task. It seems possible that participants were aware that the final task was the last and aimed to maximise reward profit as this was the last chance. However, across all participants IPs were similar at choice tasks 1 and 2 and similar at choice tasks 3 and 4. Therefore, although difficult to make any firm conclusions due to inconsistent counterbalancing and the small participant sample, it appears reasonable to argue that condition order did not noticeably affect IPs. Although it would be necessary to remain cautious about effects of condition order in the future, repeated testing using the CCT or SCT seems satisfactory.

The results of Experiment 6 showed that, in most cases, impulsivity scores obtained using one delay discounting method were predictive of impulsive scores obtained on another. This suggests that the sand timer was effective as an alternative to the computer for use with the delay discounting task. Similar correlations were found between staff impulsivity ratings and between self-report scales. There were a number of significant correlations between choice tasks and self-report measures, between self-reports and attendance, classroom behaviour and staff ratings, between classroom behaviour and staff impulsivity ratings, and between choice tasks and classroom behaviour.

Participants who presented high levels of inattentive and aggressive behaviour in the classroom (as measured using the COC) presented more impulsivity in

general according to staff members 1, 2 and 3. Adolescents who presented more inattentive classroom behaviour also produced smaller IPs on the CCTh. High percentages of inattentive behaviour related to large impulsivity scores on the Junior I.6 and low mindfulness scores on the CAMM (taken in Experiment 6), and low self-control scores on the BSCS. Adolescents who presented relatively large amounts of undesirable behaviour in the classroom chose more impulsively in two of the four choice tasks, with the exception of the CCTh and SCTs, and obtained lower self-control scores on the BSCS. Interestingly however, impulsivity did not correlate with any of the other measures taken. As the majority of the measures used in the current study were designed to assess impulsivity, the lack of relations between such measures was unexpected (see chapter 6 for a more detailed discussion of this point).

The results showed that there was a main effect of choice task method (computer versus sand timer) on IPs, with the sand-timer producing lower mean IPs than the computer, indicated that participants made most impulsive, less delay tolerant choices, in this condition. This was particularly interesting in the light of initial concerns that guided the design of the computerised choice task. As mentioned in chapter 1 of the present thesis, Cooper (1996) defined children and adolescents with behavioural, emotional and/or social difficulties (BESD) to include individuals with Autism Spectrum Disorders (ASD) and Attention Deficit Hyperactivity Disorder (ADHD). According to the DSM-IV-TR (2000), a characteristic common in children and adolescents with such difficulties is inattention. Therefore it was considered important for the task to be made engaging, or risk participants continually choosing the smaller sooner reward. It was for this reason that the CCT was presented in the form of a simple

computer game. However, the results of the present experiment were that the most self-controlled choices were produced in the CCT.

As mentioned in section 5.1, previous research (such as Malone, 1981; Donchin, 1995) has reported the effect of extended attention whilst playing video and computer games due to aspects of enjoyment and excitement they create for the player. Therefore the finding in Experiment 6 that the computer choice task (CCT) produced more self-controlled choice responding than the SCT was unsurprising. It is possible, that some aspect of the Computer Choice Task (CCT) might itself have functioned as a generalised reinforcer, and consequently prolonged access to it may have supported greater tolerance of delays than is commonly produced in other interactions.

Antonietti and Mellone (2003) reported evidence to suggest differences in playing a simple board game on a computer compared to the same game played on a board was due to possibilities created by the computer (such as making faster, easier moves) "rather than features of the computer itself" (p. 133). However, it could be argued that the tasks involved in the CCT and SCT were quite different. The SCT involved the participant having to wait for the sand to filter through, whereas the CCT involved basic visual effects and created anticipation of a gun being fired and a spaceship being blown up. Therefore it is possible that the higher tolerance of delays presented by participants in the CCT was due to some feature of the computerised game-type task rather than the computer itself.

Although adolescents would not have been aware of the exact delay used in the SCT, the increase in the volume of sand when timers were changed was likely to have provided a cue to indicate an increase in delay. On the other hand, it was possible that the adolescents were unaware of any increase in delay in the CCT as there was no visual indication of an increase in time. It is possible therefore that the adolescents produced smaller IPs (were more impulsive) in the SCT because the increased volume of sand provided a cue for impulsive responding. However, after the first increase in delay in the CCT (from the 30s practice to the 60s delay) the adolescents might have been aware of a possible increase in forthcoming delays. Nonetheless, such knowledge was dependent on participants choosing the LL reward on at least one occasion in two successive delays.

Most participants in Experiment 6 made at least one LL choice in the 30s practice and one LL choice in the 60s delay in each choice task. The exceptions to this were P1616, P236, P13625 and P1626 (in the SCT<sub>h</sub>), and P1623 (in the SCT<sub>s</sub>) who did not choose LL in the practice, but choose LL at least once in both the 60s and 90s delays. For four of these participants the choice task in which this occurred was the last task they received and therefore it was likely that they were aware of the increase in delays having experienced the increase of delays in the three previous tasks (Figure 5.5). For P1616, the SCT<sub>h</sub> was the second task he received and therefore he might not have expected the increased delay, and consequently chose LL more frequently. Still, given the DAA used, P1616 could have chosen SS in the remaining trials if he did not want to wait for the delay again. P1417 was the only participant to choose SS across all delays in the SCT<sub>h</sub>, however again this was the last task he received

and therefore had experienced the increase in delays in the previous three tasks. Although not mentioned within the results, many adolescents also pointed out their expectation of an increase in delay before the start of each delay. Therefore, it seems reasonable to argue that within the current study, the SCT and CCT were similar because participants expected an increase in delay, without being explicitly informed.

Future researchers might want to be transparent about delay lengths or set up practice tasks to prepare participants for increasing delays. It is important to consider this in relation to both past and future research as studies investigating delay discounting appear to differ in informing participants of the length of delays. One matter relating to this concerns the ecological validity of knowledge of delay length within discounting tasks. Options requiring choices between consequences that vary in size and delay are regularly presented to humans and animals within their everyday lives. For example, should the eagle catch the mouse now or wait to catch a rabbit? Should one eat crisps and chocolate snacks now or not eat them and increase the likelihood that one will be thinner in a few months? Such examples involve no knowledge of the delay to receipt of the larger, more potentially beneficial reward. Alternatively, other choice options have clear delays to receiving the larger later reward, such as: Should I spend money on those new shoes or put it into an ISA to increase the amount of interest I will receive at the end of the financial year? Therefore, it is important to consider the population sample you are studying and the conclusions to be drawn from the research.

With regard to the present project, although token economies (section 1.1) were in place at the school, the knowledge of the amount of delay to receiving the beneficial consequences of self-controlled behaviour are limited, such as staying in class to learn rather than running around outside with friends and saving money. Although adolescents in the present project expected an increase in delay, the delays were not explicitly known. It could be maintained that such knowledge is similar to choices faced daily by the adolescents, such as whether to stay in class and learn, or leave class and have fun with friends, and therefore, the choice tasks used in the present project appear ecologically valid.

Correlational analysis revealed a number of significant positive relationships between IPs obtained in the different choice tasks, further suggesting the SCT provided an effective equivalent of the CCT in which reward value was presented and received in a similar manner. Participants were required to interact with a computer in the CCT and the experimenter in the SCT. Therefore it seems possible that, as individuals with ASD present impaired social interaction (DSM-IV-TR, 2000), these participants found the SCT more demanding and subsequently chose SS more frequently to remove themselves from the situation. However, it does not seem that this was the case, as P1317 was the only participant with a diagnosis of ASD to present least delay tolerance in the tasks involving the Sand timer. Other participants with ASD or AS (e.g., P196, P13625 and P13622) maintained a stable toleration for all delays and across all choice tasks. The latter could reflect the characteristic of ASD concerning repetitive behaviour patterns (DSM-IV-TR, 2000).

Given the finding that the computer game-type task may have influenced participants' responding, consequently affecting IPs, it was decided that the SCT would be the better measure of impulsive choice in adolescents with BESD. Furthermore, the concern that participants with ASD may discount more quickly in the SCT to avoid the social interaction was reduced as only one out of the twelve participants who had ASD or AS in their diagnosis obtained smallest IPs in the SCT (both in school and in the house).

The results of Experiment 5 raised the suspicion that participants may have been more tolerant of delays because choosing the delayed option prolonged their time away from ordinary classes. Although analysis of the present experiment revealed no significant main effect of location on participant's choice responding, there was a significant interaction in that participants were generally more impulsive in the context of the house when the form of task was the sand-timer. It is possible that participants chose more impulsively in the SCT<sub>H</sub> as they were more interested in engaging in preferred activities (such as playing computer games with friends) during residential time. The largest mean IP for the 20 participants was produced in the CCT<sub>H</sub> condition (Figure 5.3) possibly due to familiarity of interacting with a computer during residential time. The wider implications of location and method of testing will be discussed in detail in chapter 7.

Although correlations within and between different measures of impulsivity were identified, they were inconsistent. For example, the Junior I.6 only correlated with other self-report measures, behavioural observations and staff ratings, but not with class attendance or delay discounting. This is a recurrent finding in the



present thesis (see chapters 3 and 4). Reynolds, Ortengren, Richards and De Wit (2006) reported a similar finding that behavioural tasks did not correlate with self-report measures of impulsivity. Following a continuation of their analysis they suggested that the behavioural tasks and self-reports were likely to “measure different constructs, and suggest that even among the behavioural measures, different tasks measure different, perhaps unrelated, components of impulsive behaviour” (p. 306). The existence of different forms or sub-types of impulsivity has also been suggested by Mobini, Grant, Kass and Yeomans (2007) and research presented by Miller, Joseph and Tudway (2004) further suggested impulsivity to be a multi-dimensional construct. Exploring whether impulsivity has different forms in future research may produce valuable contributions to the understanding of impulsive behaviour, as well as other impulse control disorders such as alcoholism, gambling, drug addiction, spending behaviour and individuals with behavioural, emotional and social difficulties (BESD).

Results from Experiment 6 showed that there was no statistically significant effect of method (computer compared to a sand-timer choice task) and no significant main effect of location (school compared to a residential setting). It must be acknowledged that the power of this design to detect any effects is likely to have been affected by the small number of participants. Even though there was no significant effect of location, there was a large interaction between task (method) and location, suggesting that task type made little difference in school, but a large difference between tasks in the residential setting. The large effect of task type in one location emphasises the need for consideration of tasks and the location. The main effect of task method raises questions as to

the generalisability of previous research that used computerised tasks. In addition, the general inconsistency between measures of impulsivity requires examination. It may be better to investigate whether different dimensions of impulsivity exist in order to facilitate understanding, diagnosis and treatment of individuals with impulse control disorders.

Although results from individuals on a single choice task were often unsystematically variable, averaging over the 20 participants and the four choice tasks showed the expected delay effect. Therefore, the choice tasks may not be suitable as diagnostic tests of impulsivity at an individual level for adolescents with BESD. Furthermore, the choice tasks appeared to be context specific and consequently not generalisable to other contexts. Additionally, the six trials to obtain an indifference point at each delay could be argued to be too few to generate stable behaviour for all participants.

Despite mixed correlations between the different measures used, the results of Experiment 5 were supported, as adolescents with higher impulsivity (Junior I.6) scores generally reported less mindfulness (CAMM) and less self-control (BSCS) in the present experiment. This provides evidence, in line with previous results within the present thesis, to suggest a relationship between impulsivity and mindfulness may exist. Thus the extent to which impulsivity could be altered through mindfulness skills training still appeared to be worth investigation.

As a result, a further experiment (Experiment 7) was proposed in which a mindfulness based training intervention would be delivered to a small number of

adolescents with BESD. Measures used in the present experiment could be administered, with the exception that only the SCTs would be used as the measure of impulsive choice, and several additional measures taken at a number of points throughout a multiple baseline design. To this end, it was necessary for measures such as the self-reports to have satisfactory test-retest reliability.

The results of Experiment 6 indicated satisfactory 5 month test-retest reliability (.632) of the Junior I.6 (similar to that reported in Duckworth & Seligman, 2005) but not for the CAMM. Attempts to find previous research regarding test-retest reliability of the CAMM were unsuccessful, and consequently an additional mindfulness measure that had satisfactory test-retest reliability was sought to gauge the progress of mindfulness training in Experiment 7 (see chapter 6 for details).

Mindfulness-based interventions are increasingly being adopted to improve the psychological wellbeing of individuals suffering a variety of difficulties, such as depression, stress reduction and pain. More recently work has focused on the benefits of such an approach to children and adolescents. The actress Goldie Hawn for example, has set up a foundation to educate children using principles of mindfulness. In response to finding a possible relation between impulsivity and mindfulness it was considered that an approach adopting mindfulness-based training might be beneficial to decreasing impulsive behaviour and in turn improving the self-regulation of behaviour in adolescents with BESD.

## **Chapter 6: Experiment 7**

### **Mindfulness Training Intervention**

#### **6.1 Introduction**

As mentioned in previous chapters, adolescents with emotional and behavioural difficulties (BEDS) often present highly impulsive, often challenging behaviour. Approaches such as token economies and cognitive behavioural therapy have been used to support the development of such individuals (Martin & Pear, 2007). Preceding research in the current thesis found evidence to suggest that highly impulsive individuals (as identified by self-report scales) presented less mindful awareness; that is they were less able to access and observe their own thoughts and feelings in a non-judgemental manner. As suggested by Frith and Happé (1999) and Thompson (2008), it could be proposed that the ability to possess self-awareness may be a skill that can be altered through training. This in turn leads to the question of whether it would be possible to reduce impulsive behaviour and improve self-awareness through mindfulness-based skills training sessions.

As was mentioned in section 1.12 of the current thesis, previous research has described successful effects of mindfulness training. For example, Singh et al. (2006) reported a decrease in aggression in individuals with developmental disabilities. The aim of Experiment 7 therefore, was to determine whether it was possible to decrease impulsive behaviour and increase mindfulness in adolescents with BEDS through the implementation of a mindfulness-based training intervention.

### **6.1.1 Therapy Training**

Although there is a rapidly increasing volume of research on the effects of “third-wave behaviour therapy” (Bishop et al., 2004; Hayes, 2004), only a small proportion has involved children and adolescents (Greco & Hayes, 2008). However, Bögels, Hoogstad, Van Dun, De Schutter and Restifo (2008) found preliminary evidence to suggest that mindfulness training improved sustained attention and self-reported happiness, mindful awareness, personal goals, and internalising and externalising complaints in adolescents with externalising disorders (i.e., those primarily manifested in children's outward behaviour such as behavioural control, attention and impulse control difficulties, including Attention Deficit Hyperactivity Disorder, ADHD; Oppositional Defiant Disorder, ODD; Conduct Disorder, CD; and Autistic Spectrum Disorder, ASD) and their parents.

As well as there being limited literature in this area, the research team and therapy team at the school had limited experience of mindfulness-based training prior to the study. Further, no specific program of study exists to qualify an individual to administer mindfulness therapy. Therefore, the researcher first attended two experiential courses in ACT (one delivered by Kelly Wilson), studied written material, and joined special interest groups. The researcher also consulted ACT and mindfulness therapists including Steven Hayes, Kelly Wilson, Sue Clarke, Richard Wicksell, Laurie Greco and Amy Murrell (for further details on ACT Therapists see [http://contextualpsychology.org/therapist\\_referrals](http://contextualpsychology.org/therapist_referrals)) to learn how to deliver mindfulness-based training and how to apply it to adolescents with emotional and behavioural difficulties.

It is also important to note that the researcher personally practised mindfulness exercises prior to and during the present research to develop an understanding of mindful awareness, as emphasised by Kabat-Zinn (2003). In an effort to validate the mindfulness-based training performed by the relatively inexperienced researcher an experienced mindfulness therapist was sought to supervise therapy content, however, this was unsuccessful. Segal, Williams and Teasdale (2002) in their book titled 'Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse' provide transcripts and practical details on implementing an 8 week mindfulness-based training programme.

Bögels et al. (2008) adopted a similar 8 week programme in which 14 adolescents (aged between 11 and 18 years) and 12 of their parents received mindfulness training sessions in groups (the results of which are mentioned above). The session content and structure were similar to those presented in Segal et al. (2002), in which sessions were conducted as follows: Body Scan, Mindful Breathing, Breathing Space, Mindfulness of Thoughts and Sounds, and Mindful Sitting.

Although the mindfulness sessions in Bögels et al. remained the same as in Segal et al., the training was adapted for use with parents and to the age and difficulties of the adolescents. For the adolescents, meditation exercises were shortened, varied and involved more tangible tasks (e.g., "yoga, massage, mindful walking outside, mindful eating, mindful listening and mindful speaking", p. 199). Additionally, exercises were directed towards specific themes (such as impulsivity). For example, every child in the group was given half a chocolate

bar (their favourite) and told that the trainers would leave the room for a period of time (undefined). During this time trainers recommended the children practise mindful breathing. If the children had not eaten the half by the time the trainers returned, they would be given the other half to eat and encouraged to discuss their experiences.

Mindful sitting involved the introduction of specific difficulties, "such as being humiliated" (Bögels et al., 2008, p.197), while trainers encouraged children to note their reactions to these difficulties, become aware of their thoughts and feelings and to accept them (e.g., say to self "It's OK. Whatever it is, let me feel it", p. 199). Difficult experiences were also role-played within the group. Trainers encouraged children to be mindful of their thoughts and feelings during the experience, then invited children to do a 3 minute mindful breathing exercise. This was followed by a re-play of the difficult experience in which the child who experienced the difficult situation was encouraged to answer, rather than react to, his or her difficult experience based on the mindful awareness practiced in the breathing exercise.

In the study by Bögels et al., measures were administered immediately before the intervention (sessions commenced immediately for four individuals and their parents) or before and after a waiting period (ten individuals and their parents were required to wait between 6 and 23 weeks (with a mean wait of 13 weeks) prior to commencement of the intervention to control for time and assessment effects), after the 8 week mindfulness intervention (post-test) and after an 8 week follow-up. Measures administered to the children included the Goal Attainment Scale (GAS) to assess improvement on personal goals, the Youth

Self Report (YSR) to assess symptoms of externalising disorders, the D2 Test of Attention to assess sustained and directed attention, the Subjective Happiness Scale (SHS) to assess improvements in happiness, the Paediatric Quality of Life Inventory (PQLI) to assess quality of life and the Mindful Attention Awareness Scale (MAAS) to assess improvements in mindful awareness. Measures administered to the parents included the GAS to assess personal goals and goals of their child, Child Behavior Checklist (CBC) to assess their child's symptoms, Children's Social Behavior Questionnaire (CSBQ) to assess behaviour difficulties of children with ASD, the Self Control Rating Scale (SCRS) to assess their child's self-control and the PQLI to assess quality of life for themselves and their child.

Experienced cognitive behavioural therapists who had received training in mindfulness by Mark Williams delivered the mindfulness training to the children and parents (therapists met weekly with Susan Bögels, lead author, to discuss issues). Four groups: two groups each of 7 children and two groups each of 6 parents or parent couples were run in parallel and sessions lasted 1.5 hours. Parents and adolescents were given session notes, instructions and a CD with audio recordings of mindfulness exercises, and homework (if sessions were missed, children and parents would be sent session handouts so that homework could still be completed). Children and parents were also asked to provide a plan in the eighth session for continuing mindfulness practice during an 8 week follow-up.

Furthermore, adolescents in Bögels et al.'s study received reward points for session attendance to encourage motivation to practise and engage in



sessions, although a total of five adolescents (all boys with ODD/CD) and three parents dropped out of the mindfulness intervention. According to Bögels et al., some adolescents had difficulties concentrating and were noncompliant within the group sessions. For example, participants played with their mobile phones, listened to their MP3 players and smoked during mindfulness sessions. Parents arrived late, did not complete and lost homework and disturbed others. Bögels et al. therefore suggested similar future mindfulness sessions be conducted individually initially to engage adolescents with ODD/CD to increase treatment completion. In addition, it seems reasonable to question whether the 1.5 hour sessions were too long for adolescents with attention difficulties to participate in a single session. It seems possible that this might have affected the quality of mindfulness practice, session participation and research outcomes.

Experiment 7 was designed to determine the effect of mindfulness-based skills training sessions on a number of relatively standard measures of impulsivity and mindfulness in a small sample of adolescents with a range of behavioural, emotional and social difficulties (BESD). The experiment was designed in accordance with several points raised in Bögels et al., including adopting an individual approach to training for all adolescents, staggered starting points (to control for time effects), an 8 week mindfulness intervention and pre- and post-intervention control phases to control for time and experimenter effects.

Since the majority of pupils at the participating school were enrolled on residential placements, it was not possible to run mindfulness training with parents. Also, given the difficulties that staff reported concerning limited homework completion and the problems met by Bögels et al., it was decided

that participants would not be required to do homework, but were instead encouraged to practise mindfulness when possible (see section 6.2.3 for more details). It was proposed that this would provide less of a barrier to practising mindfulness and left it up to the individual to decide whether or not to practise mindfulness outside of sessions. In accordance with the literature presented in section 1.12 and that reported here, it was hypothesised that mindfulness training would reduce impulsive behaviour and self-reported impulsivity and increase mindful awareness in adolescents with BESD.

A number of measures used and developed in the present project were taken at different stages of the programme to determine the effect of the mindfulness-based training on impulsive behaviour and mindful self-awareness in adolescents with BESD. The Sand-timer Choice Task in school (SCTs) was used to measure impulsive choice as the sand timer had been identified as the most reliable measure of impulsive choice in Experiment 6. However, due to unforeseen bracketing problems with delays presented in the SCTs (as explained further in this chapter), it was considered necessary to include an additional measure of delay tolerance.

A recent study (Beran & Evans, 2009) that revealed the availability of work was beneficial to producing self-controlled choices in chimpanzees (when reward accumulation was contingent on work performance), involved a delay maintenance procedure in which reward amount increased the longer the participant waited for reward receipt. Toner, Lewis and Gribble (1979) and Toner and Smith (1977) adopted a similar task in finding evidence to suggest positive verbalisation concerning waiting (e.g., "It is good if I wait", p. 125),

improved children's delay tolerance. Toner et al. (1979) placed M&M sweets (wrapped individually in foil and referred to as 'tokens'), one every 30 seconds, onto a table in front of a child until the child either told the experimenter to stop, took the tokens, or the maximum time (10 minutes) was reached. The measure of delay maintenance behaviour was calculated as the duration (in seconds) between initial placement of a token and the point at which the task was stopped. The question of how long the adolescents would wait for a monetary reward was raised and it was considered possible that a similar measure could be designed for use in Experiment 7 to determine this.

Therefore, the aims for Experiment 7 were to firstly design a measure of delay tolerance, and determine whether it was more effective in bracketing adolescents' responding than the delay discounting task. Secondly, given the inconsistencies in correlations between measures throughout previous studies in the present thesis, relations between impulsivity measures were further explored. Experiments within the present thesis showed some evidence to suggest that a relationship between impulsivity and mindfulness may exist. As a result, the third aim of Experiment 7 was to determine whether a brief mindfulness-based intervention could increase mindful awareness and self-control, and decrease impulsivity in adolescents with BESD. To this end, a measure of delay discounting, a measure of delay tolerance, and questionnaires for impulsivity, self-control and mindfulness were administered, and school information on safety holds and lesson attendance, classroom observations and staff impulsivity ratings were obtained (see section 6.2.2 for details).

## 6.2 Method

### 6.2.1 Participants

The participants recruited were six male adolescents 14 to 16 years of age (with a mean age of 14 years and 6 months,  $SD = 0.8$ ) with a range (see Table 6.1 for details) of behavioural, emotional and social difficulties (BESD). Originally seven participants were recruited and consented to participate but one (P410) was removed early from the study due to inconsistent school attendance. Four participants were enrolled on residential placements, and two (P1417 and P411) attended school daily. None of the participants recruited had participated in any previous studies in the current thesis.

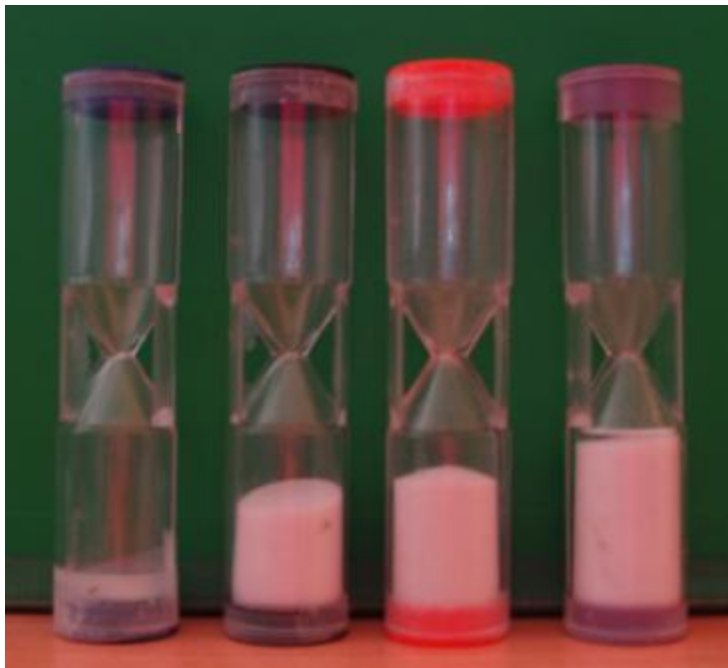
Table 6.1 *Each Participant's ages and Special Education Needs.*

P No	Age (years)	ADHD	ASD	AS	ODD	BESD	PTSD	PDAS
P1417	14	<b>X</b>				-		
P727	15		<b>X</b>			-		
P622	14	x		<b>X</b>	x	-		
P2117	16					<b>X</b>		
P1415	14					-	<b>X</b>	
P411	14	x		<b>X</b>	x	-		x
P410	15	<b>X</b>	<b>X</b>			-		

*Note: Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Asperger's Syndrome (AS), Oppositional Defiant Disorder (ODD), Post Traumatic Stress Disorder (PTSD), Pathological Demand Avoidance Syndrome (PDAS).*

### 6.2.2 Materials

The choice task involved the use of four sand timers (similar to those previously used in Experiment 6) with time durations of 30s (seconds), 120s, 150s and 180s (see Figure 6.1). Reliability was previously tested on the 30s and 120s sand timers (see Experiment 6 for details), therefore the same reliability test was conducted on the 150s and 180s sand timers prior to Experiment 7. Averages across ten test-retest trials were 150s ( $SD = 2.6s$ ) for the 150s timer and 175s ( $SD = 3.2s$ ) for the 180s timer.



*Figure 6.1* Sand timers (30s, 120s, 150s and 180s) used in the SCTs in Experiment 7.

Two transparent containers were used (see the general method section 2.2.2 for details), twelve reward cards ranging from 0p to 10p for SS rewards and a single 10p card for the LL reward (see section 5.2.2 for full details of the materials used for the SCT).

Since data from Experiment 6 suggested the CAMM lacked test-retest reliability, Brown and Ryan's (2003) Mindful Attention Awareness Scale (MAAS) was additionally administered to assess consistency with the CAMM. Therefore, the four questionnaires used were the Junior I.6 Impulsivity Scale (Eysenck, Easting & Pearson, 1984), the Child Acceptance and Mindfulness Measure (CAMM; Greco & Baer, 2005), the Brief Self Control Scale (BSCS; Tangney, Baumeister & Boone, 2004), and the Mindful Attention Awareness Scale (MAAS; Ryan & Brown, 2003). The MAAS required participants to rate their experience of each of 15 statements from 1 (*almost always*) to 6 (*almost never*). The MAAS was reported to have good (.81) test-retest reliability, internal consistency and validity. Other materials included information sheets for staff (Appendix V) and participants (Appendix W), consent forms (Appendices X and Y), instructions, brief and debrief documents (see Appendix Z), and staff general impulsivity rating sheets (see Appendix P and section 4.2.2).

Data were also obtained from information staff had recorded and analysed throughout the school year to monitor pupils' behaviour. Such data included safety holds during educational and residential periods and lesson attendance. As in Experiment 6, to obtain an objective measure of impulsivity, four members of therapy and teaching staff at the school were asked to rate pupils' general impulsivity in school on a 1 (*never*) to 10 (*always*) point scale (see section 4.2.2 for details), and behavioural observations were conducted using the Classroom Observation Code (Abikoff & Gittelman, 1985). Each classroom observation was divided into sixty-four 15 second intervals in which all 12 behaviours were

coded, and analysed in the composite groups outlined in Table 5.3, section 5.2.3.

An MP3 player was used through which an MP3 file (see Experiment 5, section 4.2.2 for details) was played to enable the experimenter to code behaviours reliably without the need to visually monitor time. Behaviours were coded using observation checklists designed for use with the Classroom Observation Code (COC; Abikoff & Gittelman, 1985). Magazines for reading in the control sessions included Chelsea Official Magazine (2009), Inside United (2009), Match! (2009), Match of the Day (2009), Simpsons (Groening, 2009), and Bart Simpson (Groening, 2009). An HP® Pavilion Entertainment PC tx1000 presented the progressive delay task and played the music and mindfulness tracks.

Compact discs containing a selection of popular, appropriate music (including artists such as Exhibit, Eminem, Jay Z, and Cascada) were used in the mindfulness of music exercise. Mindfulness recordings used included Part 2: Awareness, Part 3: Thoughts, Part 4: Eating a Raisin, Part 5: Walking and Part 6: Just Sitting. These were created by Julian McNally (2006) as part of the RMIT University (The Royal Melbourne Institute of Technology) counselling service to support students throughout their studies (see Mindfulness And Being Present, Audio and Worksheets, Chapter 4, 6 ACT Conversations, [www.contextualpsychology.org](http://www.contextualpsychology.org)). Additionally, mindful walking handouts and question sheets, session comment sheets, and sweets for the eating exercise were required (see Table 6.2 below for details of exercises).

### **6.2.3 Design and Procedure**

In an attempt to provide validity regarding mindfulness training the researcher adopted aspects of training and recommendations outlined by Bögels et al. (2008) due to comparability of participants to those in the present study, and audio recordings (McNally, 2006) were used to ensure sessions conformed to mindfulness principles. The audio recordings (as outlined in Table 6.2) provided direct instructions for the participant and researcher to jointly follow and enable the researcher to give prompts, such as re-focussing participants, during recordings. Given the difficulties Bögels et al. experienced with distractions and non-compliance, it was considered important, especially during initial mindfulness sessions, for the researcher to actively participate and model appropriate focussed behaviour to encourage active engagement and desirable behaviour of the participants. Furthermore, in light of issues met in the Bögels et al. study (section 6.1), to facilitate participation in sessions and engagement in mindfulness exercises, sessions were completed one-to-one rather than in groups. Unlike in the study by Bögels et al., pupils were not allowed mobile phones in school or to smoke and therefore, such distractions were not present in the current experiment.

Participants were presented with a set series of sessions in the initial session, however, this was not maintained as it became clear throughout the training that students disliked some exercises and preferred others. In an attempt to engage and motivate participants, sessions were selected by the experimenter on the specific motivations of each participant. Often successful exercises involving motivated engagement and positive behaviour were repeated to support



participants' attention and motivation to complete the training. However, unlike in Bögels et al., sessions did not specifically focus on difficulties the boys had recently experienced as therapy staff at the school had reported that pupils frequently displayed barriers to discussing such issues. Instead, if and when issues such as these arose, the researcher would encourage mindful thinking of difficult issues and mindful breathing exercises. Although the boys were not required to do homework, they were advised to practise outside of sessions. Each boy was asked whether they had practised and this was discussed in sessions.

A multiple-baseline between-subjects design was used in which all participants received a 16 week program in the form of a 4 week pre-intervention control, an 8 week intervention and a 4 week post-intervention control. The control phases required pupils to read aloud to the researcher as this was a valuable activity for the student to engage in, and therefore an efficient use of time.

Table 6.2 *Details of mindfulness exercises.*

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Exercise name and details

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**Breathing:** Introduction to mindful breathing. Attention on breath: focus on air entering/leaving nose/mouth, notice rise/fall of chest/stomach, re-direct attention to breath as attention wanders (e.g. “I’m not doing very well”).

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**Thoughts:** Focus on one aspect of breath (e.g. rise/fall of stomach). Notice/observe thoughts coming/going (e.g. like watching clouds float by), without getting hooked into them or trying to stop/change/avoid them. Notice thoughts change, stay the same, re-appear, how fast they go, differences between them (e.g. positive/negative/emotional).

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**Eating:** Participants disliked dried fruit - small chewy sweets (e.g. Cola Bottles) used to encourage engagement. Study food visually - notice textures/colours/weight (e.g. sticky/dry), smell and feeling on lips, thoughts (e.g. ‘want to eat it’). As move it around mouth, notice tastes. As bite into it notice juices release. Feel food going to stomach and no longer there.

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**Walking:** Acknowledge beginning of walk. As walk, pay attention to bodily sensations (e.g. feet on ground, feet/ankle/muscle/chest movements, notice arms swinging, breathing), differences in right/left body side. Focus on environment (e.g. temperature/wind), notice thoughts and feelings (e.g. ‘this is boring’). Acknowledge end of walk. (*Outside*).

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**Sitting:** Chair/floor, upright spine, relaxed. Acknowledge thoughts/feelings/urges (e.g. itch) - let them come/go without getting hooked into them (more difficult as less structured instruction).

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**Music:** Sit, spine upright, just listen. Acknowledge urges/ thoughts/feelings (e.g. tap foot to beat) - let them come/go. Listen to music sounds/beats.

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The intervention phase entailed an 8 week mindfulness-based skills training programme. All sessions were implemented during the school day by the researcher to ensure consistency of programme delivery between sessions. Sessions lasted between 30 and 45 minutes (rather than the 1.5 hour sessions carried out in Bögels et al.'s study) and were conducted individually in small rooms at various locations throughout the school. The six participants were divided into three groups of two by the Head of Education at the school to correspond with pupils' daily routines. Weeks in which each pair of participants commenced their participation in the study were staggered (see Figure 6.2) to enable the detection of any considerable changes in participants' behaviour as a result of external variables.

For each participant, measures were intended to be taken on week 1 (baseline), week 4 (pre-intervention), week 12 (post-intervention), and week 16 (follow-up) of their 16 week programme. Although it was possible for pupils to attempt prolonging time out of class, all measures were performed during school time in an attempt to maintain context consistency between measures, classroom observation, mindfulness intervention, and control sessions. Measures were not administered immediately after control or intervention sessions to keep session duration and duration of measures as short as possible.

The SCTs initially presented participants with delays of 30s and 120s as these had successfully bracketed participants' discounting in preceding research. However, due to unforeseen high toleration of the 30 and 120 second delays, 150 and 180 second delays were introduced as additional delays to measure

participants' discounting. These delays were selected in an attempt to bracket discounting in highly delay tolerant participants and those participants who were less delay tolerant. As participants were started two per week over a 3 week period, the additional SCTs with delays of 150 and 180 seconds were conducted after the initial baseline measures taken in week 1. Following presentation of these additional delays (before the intervention sessions commenced), three delays (30s, 120s and 180s) were selected and used for the remaining SCTs measures to bracket participants' delay tolerance and fit within the time constraints of the session.

Although there was a large variation between the lengths of delay participants would tolerate, some participants continued to tolerate the additional delays introduced in the SCT. Further increased delays could not be introduced due to time limitations and therefore a novel measure (the Progressive Delay Task) was introduced at pre-intervention to rapidly determine how long the participants *would* wait. This was a Progressive Delay Task (PDT) whereby participants were required to sit quietly and still on a chair in front of a computer screen which presented them with a countdown timer. The participants were told that every time the clock reached 0 the experimenter would put a 1 penny coin in the transparent container next to the computer screen and re-start the countdown timer. The participants were asked to say "stop" when they did not want to continue waiting for 1 penny coins. The initial delay was 20 seconds which increased with each re-setting of the clock by a progression factor of 150% until the participant said "stop".

Given the high tolerance of delays in previous experiments in the current project, it seemed possible that the LL reward was too attractive in relation to the delay duration. However, given the constraints on session duration (e.g., academic and vocational commitments), it was not possible to increase delays. Therefore, to make the SS option more attractive in the PDT, participants were told at the beginning of the PDT that the experimenter would put ten additional one penny coins into the transparent container when they said “stop”. These 10 one penny coins were placed next to the transparent container throughout the task. The data recorded for the PDT was the total duration (seconds) of the last full delay tolerated. However, if the participant said stop during a delay, but the number of seconds he had tolerated was more than the total duration of the previous delay, the largest delay duration was recorded.

Classroom observations using the Classroom Observation Code (COC; Abikoff & Gittelman, 1985) were conducted weekly on each pupil, except for a few instances where participants were not in school or refused to attend lessons. All observations were conducted by the principal researcher and generally lasted 16 minutes. Observations were mostly conducted in English lessons as initially six out of the original seven participants were taught English by one particular teacher. This maintained consistency between observations, thus reducing potential effects of teacher and lesson variations. Originally P727 was the only participant in this research to be in a class where the majority of the academic curriculum was taught by the same teacher throughout. Consequently this participant was taught English by a different teacher to that of the other participants. However P1415 was moved into this class during week 13 of the

24 observation weeks due to him presenting increased undesirable behaviour and insufficient learning.

A number of observations were shortened due to boys removing themselves from class or being removed from class as a result of unacceptable behaviour. On average each participant was observed for a total of 50.5 (range 0 to 96 ) minutes in the baseline phase, 109.3 (range 96 to 128) minutes in the pre-intervention control phase, 198 (range 152 to 256) minutes in the intervention phase and 125.3 (range 80 to 160) minutes during the post-intervention control phase and follow-up. Sixty-four percent of classroom observations were English lessons, 12 percent were Maths lessons, 9 percent were Science lessons and 15 percent were Personal, Social and Health Education (PSHE) and ASDAN (Award Scheme Development and Accreditation Network) lessons. The latter is a charity run to advance education "by providing opportunities for all learners to develop their personal and social attributes and levels of achievement through ASDAN awards and resources" (Asdan Education, n.d.).

General Staff Impulsivity Ratings (SIR) were obtained from therapy and education staff using a simple 1 to 10 rating scale (see Experiment 5, chapter 4, section 4.2.2). To increase the reliability of staff ratings, members of staff remained anonymous and unaware of how far through the 16 week program participants were. Self-report measures were administered in the following order for all participants throughout the study: Junior I.6, CAMM, BSCS and MAAS, to separate the impulsivity and mindfulness constructs. Behavioural measures of attendance in school and "holds for safety" in both education and residential settings were also obtained through the school.

### **6.3 Results**

The addition of longer (150s and 180s) delays required a further SCTs measure to be administered at a later date to that of initial baseline measures. Therefore, elapsing time between the initial SCTs measure and obtaining the additional Indifference Points (IP) are illustrated in the SCTs figures for each participant as a break between lines. As a consequence of staggered program start dates, line breaks appear at baseline or pre-intervention SCTs results. Because comparisons between measures were made on an individual basis, each participant will be addressed in turn. Classroom observations (COC) are presented as All Behaviour (all observed undesirable target behaviour) and divided into composite groups (as outlined in Table 5.3 above).

Originally the present programme was intended to include an 8 week mindfulness-based intervention similar to that outlined by Bögels et al. (2008), with additionally two 4 week baseline phases before and after. However, during the study the intervention was reduced to 7 weeks due to time constraints as a result of missed sessions throughout the programme. Table 6.3 below shows details of mindfulness sessions completed by each participant throughout the intervention.

Table 6.3 *Mindfulness-based training sessions engaged in by each participant.*

<b>P No</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>1417</b>	B	T	E	T	W	M	T
<b>727</b>	B	E	T	E	W	M	B
<b>622</b>	B	E	M	T	Refused	Refused	Refused
<b>2117</b>	B	T	E	M	E	M	Refused
<b>1415</b>	B	T	T	W	M	S	Refused
<b>411</b>	B	T	M	W	E	T	T

*Breathing (B), Thoughts (T), Eating (E), Walking ((W), Sitting (S), Music (M).*

As a result of missed sessions and irregular school attendance, measures were taken at different weeks to those originally planned. Specifically: Baseline measures were taken at weeks 2 (P1417 and P727), 3 (P622 and P2117) and 5 (P1415 and P411). Pre-intervention measures were taken at weeks 6 (p1417), 7 (P727 and P622) and 8 (P2117, P1415 and P411). Post-intervention measures were taken at weeks 17 (P1417 and P727), 21 (P411) and 22 (P622, P2117 and P1415). Given the time constraints, follow-up measures were only taken from three participants (P1417, P727 and P411) on week 23.

### **6.3.1 Mindfulness and control sessions**

P1417 attended mindfulness and control sessions consistently and completed the full 16 week program. During the initial mindfulness of breath and thoughts exercises P1417 remained quiet and focused but told the researcher that he rapidly became bored and slipped into an "imaginary Sci-Fi world" (apparently his way of dealing with boredom). In later thought sessions, P1417 appeared to develop improved ability to focus on his breath and increased awareness of



thoughts coming and going. He described his thoughts in Session 7 as “like a photo gallery going past”.

P1417 enjoyed and engaged well in the mindful eating, walking and music exercises and was prepared to practise independently outside of sessions at home. However, he told the researcher that he usually forgot after leaving the session, but he often listened to music in a similar way at home. Throughout the mindful walking exercise, P1417 said he noticed feelings of moving and sounds and smells in the environment more than usual. P1417 extended his walking experience to car and train journeys in which he said he enjoyed noticing objects go by without the need to think.

Participant 727 started the 16 week program at the same time as P1417 and completed all control and mindfulness sessions. Initially P727 appeared to find the mindfulness tasks difficult, but expressed amusement in engaging with the tasks. P727 stated that he did not see the point in doing the mindfulness exercises at first and had difficulty focussing in sessions. However, P727 engaged well with the music, walking and eating exercises in which he seemed able to focus his attention for increased periods of time and developed increased mindful awareness of thoughts and feelings he experienced. P727 stated that he did not perform mindfulness practices as homework throughout the intervention but was keen to practice the mindful eating task in his own time.

P622 started the pre-intervention control phase in observation week 3. He attended all pre-intervention control sessions consistently, but attendance to mindfulness sessions was inconsistent as he declined to engage in several

sessions, was often out of school due to a largely vocational timetable and work experience. Therefore, P622 engaged in four out of the intended seven mindfulness sessions, the post-intervention control phase did not occur and the fourth measures were not administered due to time constraints as a result of missed and re-arranged sessions. P622 told the researcher he found the mindfulness practices pointless, felt embarrassed engaging in the exercises and reported that he did not practice. He appeared to have difficulty focusing on the tasks, except the eating exercise in which he appeared to find it easier to observe and explore the feeling of eating mindfully.

Participant 2117 started the intervention in week 3 (with P622) and completed all four sessions in the pre-intervention control phase and six mindfulness sessions in the intervention. No post-intervention sessions were conducted as a result of five missed sessions throughout the 16 week program, due to a highly vocational timetable, similar to P622, and P2117's refusal or inability to participate on a few occasions.

P2117 engaged well with the mindfulness exercises, especially with eating and music sessions. P2117 told the principal researcher that he often listened to music mindfully to help him sleep at night and enjoys simply listening, not having to think. He mentioned that it felt strange to focus mindfully on food in the eating exercise, but found it easy to explore sensations and thoughts he had such as smell and different tastes as he moved the food around his mouth. Prior to the second eating session, P2117 was involved in a safety hold. Having calmed, he decided to participate in the session in which he appeared more able to focus on the food and express his thoughts and feelings effectively. The

principal researcher noted that after participating in the exercise, P2117's mood and attitude was more positive.

P2117 said that he found the mindfulness of breath exercise relatively easy as he was tired so relaxed and focussed on his breath. P2117 found the mindfulness of thoughts exercise difficult as thoughts such as football next lesson and the annoying voice on the recording pulled him in and he had difficulty letting them go. Problematic issues P2117 experienced at the time of the intervention were discussed in relation to the benefits of mindfulness training. However, with the exception of mindfulness of music, P2117 stated he did not practice mindfulness in his own time.

Participant 1415 started the 16 week program on week 5 and attended all sessions in the control phase and six mindfulness sessions. P1415 did not want to engage in the final mindfulness session (session 7) as he wanted to focus on school work. P1415 missed four sessions throughout the intervention and thus did not participate in the post-intervention control due to time constraints. Furthermore, in observation week 13 (intervention week 3) P1415 was moved to a different class in which the majority of the school curriculum was taught by one particular class teacher.

P1415 experienced difficulty focusing on the mindfulness exercises and said he did not see the point as he didn't think anyway, but was prepared to try. He stated that he might find it easier to do in his room and was willing to practice independently, although he told the researcher that no practice occurred. P1415 maintained focus during mindfulness of music, in which he reported hearing

different beats and sounds and appeared to become aware of thoughts coming and going. As in the sitting exercise, P1415 successfully noticed sounds, feelings and sensations during the walking exercise and mentioned similar awareness when riding his bike.

On arrival to a number of sessions P1415 appeared slightly anxious, often showing no eye contact, hiding his head in his shirt and biting his collar. P1415 regularly discussed his feelings and issues with the researcher. For example, P1415 was angry with a member of staff regarding a conversation one morning to which P1415 had ruminated about throughout the day and appeared highly agitated. However, as in other sessions, following the mindfulness of thoughts exercise, P1415's mood seemed improved and he left the session calmer and more positive.

P411 started the 16 week program on observation week 5 (the same as P1415). Although absent weeks 17 and 19, P411 attended all control and mindfulness sessions and therefore also completed the post-intervention control. P411 told the researcher he often meditated at home to help deal with problematic issues such as negative comments directed at him from other students. P411 said he often noticed smells when walking and saw it as a good way to relax, although he appeared to have difficulty focusing on feelings and experiences during the walking exercise.

The mindfulness of breath exercise P411 said was boring, but easy to do and he said he was keen to learn more. During the thinking exercise in session two, P411 found it difficult not to let the thoughts pull him in. He explained that the

thought "this is boring" kept pulling him in and went around in his head, however, P411 was willing to practice the breathing and thoughts exercises at home. During a second mindfulness of thoughts session, P411 described the thoughts pulling him in like a boat on a chain being hauled toward him. However, he found letting his thoughts go and focussing on his breath or sitting on a chair easier in the final session.

P411 had difficulty focussing on the music due to him presenting slightly immature behaviour, however he engaged well in the eating exercise in the following session. He had trouble resisting the urge to eat the sweet in the eating exercise, but noticed the "juice going all over his tongue and teeth" and said he enjoyed the food more by eating it this way so would try it at home with other foods.

### **6.3.2 Classroom observations**

Figure 6.2 below shows combined data of the percentage of All Behaviour observed for each participant and weeks in which sessions and measures were administered. As evident in Figure 6.2, the percentage of All Behaviour generally decreased from pre- to post-intervention for all participants and continued to follow-up, with the exception of P622 who attended the least number of mindfulness sessions and appeared most resistant to engaging in the mindfulness practices. Although data are variable, behaviour during the pre-intervention baseline and pre-intervention control phases remained relatively stable for participants 1417, 727 and 2117 indicating no effect of the control phase on these participants' behaviour. P1415, P411 and P622 in particular, presented slightly increased behaviour during the pre-intervention control. It

could be argued that Figure 6.2 suggests no evidence of an effect of time on behaviour, however increased behaviour was presented in weeks 19 and 20 by the three participants (P622, P2117 and P1415) who did not complete the total 7 week mindfulness intervention, two of whom were also involved in an incident in the house at the end of week 21.

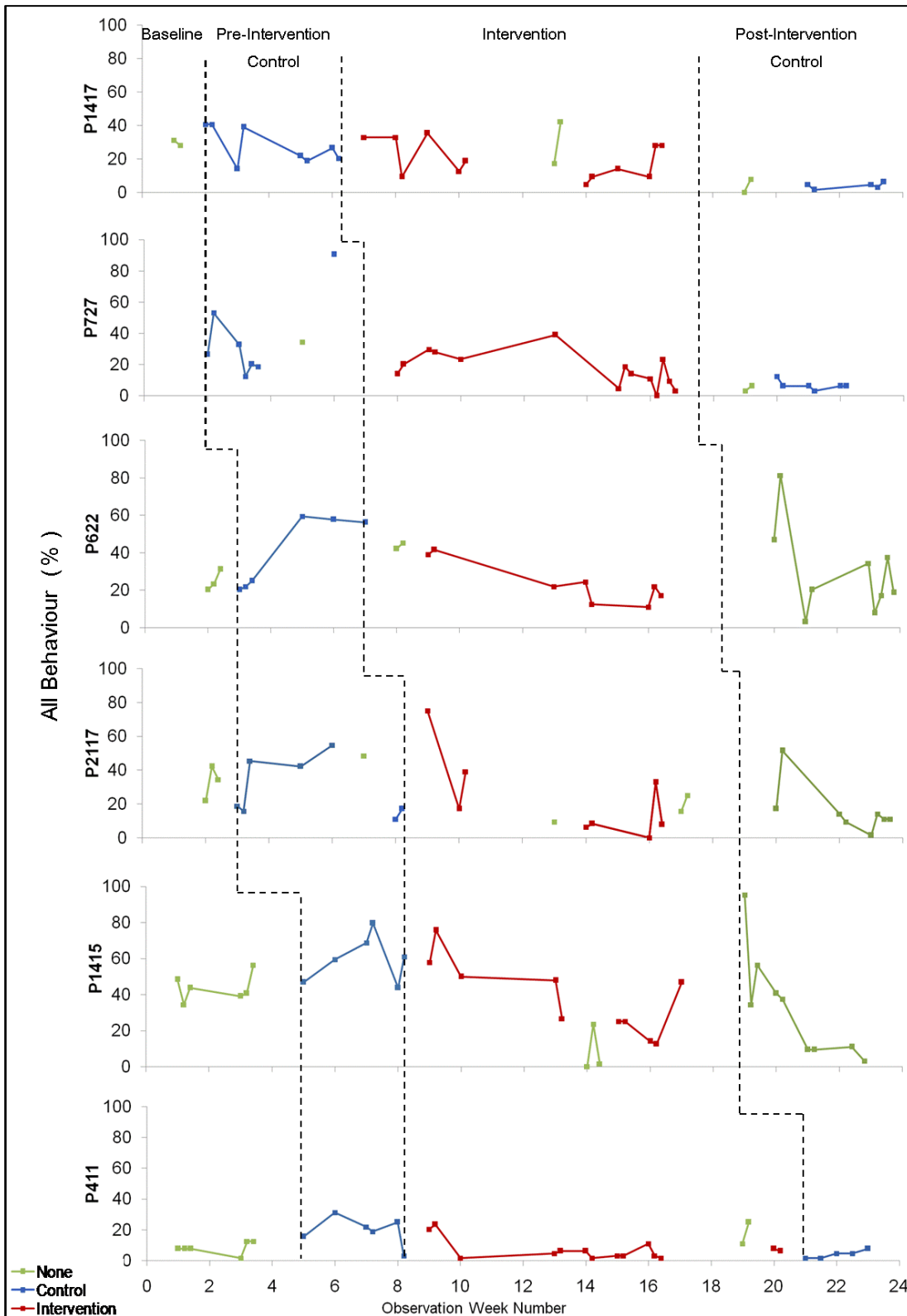


Figure 6.2 Percentage of all target behaviour observed (COC) for each participant. 'None' indicates observations on weeks in which no control or intervention sessions occurred, 'Control' involved reading sessions and 'Intervention' involved mindfulness sessions.

P1417 was observed for a total of 503 minutes over a period of 23 weeks. Thirty-one minutes of these were during the initial baseline, 128 minutes were during the pre-intervention control phase, 232 minutes were during the intervention phase and 112 minutes were conducted during the post-intervention control phase. Seventy-seven percent of these observations were carried out in English lessons and 23 percent were in Science lessons. With the exception of 1 lesson (observation week number 7 in Figure 6.3 below), all English lessons observed were taught by the same teacher and P1417 had the same teacher for all observed Science lessons. Science lessons were observed in week numbers 5, 13, 15 and 19 (Figure 6.3). Data in Figure 6.3 suggest no effect of lesson type or teacher on P1417's behaviour in lessons observed. It is important to note that weeks 4, 11, 12 and 18 were school Half Term and Easter breaks. In week 13, P1417 missed a mindfulness session, and in week 19, he missed a control session.

Figure 6.3 shows that P1417 presented approximately 30 percent of All Behaviour (all observed undesirable target behaviour) at initial baseline observations. Although variable, behaviour remained above 20 percent during the initial 4 week control phase and decreased slightly throughout the intervention, with the exception of week 16 in which behaviour slightly increased. The percentage of All Behaviour continued to decrease after the intervention and remained low, with a slight increase from 1 to 10 percent during the post-intervention control phase. In observation week 13, P1417 missed a mindfulness session and behaviour observed increased to above 40 percent. Generally, Figure 6.3 indicates a decrease in the percentage of total



intervals observed in which P1417 engaged in target behaviour across the 16 week program.

Specifically, Figure 6.3 shows that aggressive behaviours (grouped behaviour codes *A*, *AC* and *AT*) were rarely observed for P1417, with the highest presentation of 5 percent occurring on weeks 5, 7, 8 and 23. P1417 presented most aggressive behaviour during control phases and the initial intervention weeks. However, no Aggressive Behaviour was observed throughout the remaining intervention phase. As can be seen from Figure 6.3, P1417 presented approximately 15 percent of hyperactive behaviours (grouped codes *GMs*, *GMv* and *MM*) at initial baseline. Hyperactive behaviour varied throughout the 16 week program, ranging from zero to approximately 25 percent throughout the pre-intervention control and mindfulness intervention phases. Following the mindfulness intervention phase however, hyperactive behaviour presented by P1417 substantially reduced to below 5 percent.

Inattentive behaviour (grouped behaviour codes *X*, *NC* and *OC*) presented by P1417 in Figure 6.3 was under 5 percent in initial baseline observations. This behaviour remained infrequent and relatively stable across the initial control phase. An increase of approximately 15 percent was observed in week 6 of the pre-intervention control and the first two weeks of the mindfulness intervention.

Proceeding observations on weeks in which P1417 engaged in mindfulness sessions, inattentive behaviour was markedly reduced to slightly less than in the initial baseline observation. Low occurrence of inattentive behaviour continued after the mindfulness intervention through the post-intervention control and final

baseline phases. A point to highlight from Figure 6.3 is week 13 in which P1417 missed a mindfulness session and inattention behaviour increased to nearly 30 percent.

P1417 presented approximately 15 percent of impulsive behaviour at initial baseline, which increased to 30 percent after measure 1, but gradually declined throughout the initial control phase (see Figure 6.3). Although behaviour was variable, one could maintain that impulsive behaviour generally decreased slightly during the intervention and continued to decline post-intervention to below initial levels of impulsive behaviour.

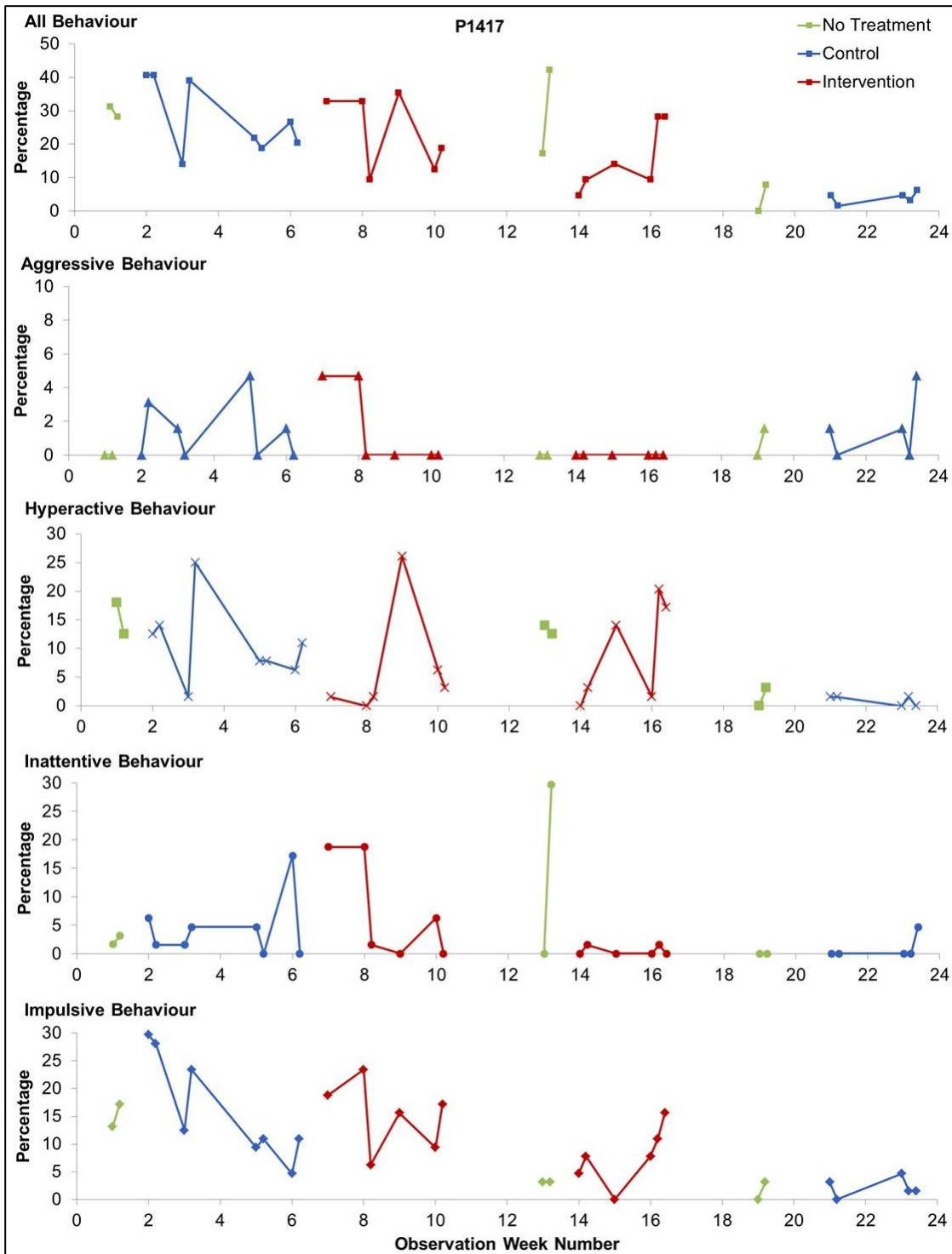


Figure 6.3 Percentage of target behaviour observed for P1417.

P727 was observed for a total of 456 minutes over the 23 weeks. It was not possible to observe P727 during the baseline phase, 128 minutes were observed during the initial control phase, 208 minutes were observed during the

intervention phase and in the second control phase a total of 120 minutes were observed. Seventy-seven percent of lessons observed for P727 were taught by the same teacher and were of core subjects including English, Maths, Science, Asdan and PSHE.

Figure 6.4 shows the percentage of All Behaviour P727 presented varied greatly, initially ranging from 0 to almost 90 percent during the pre-intervention control phase. Behaviour decreased slightly during the first 3 weeks from 60 to 20 percent, but increased to almost 90 percent on week 6. During weeks 8 to 14 behaviour increased from approximately 15 to 40 percent, then decreased to below 20 percent throughout the remaining intervention weeks. Behaviour presented by P727 remained below 15 percent during the post-intervention control phase.

Aggressive behaviour presented by P727 ranged from 0 to 17 percent throughout the 24 weeks of observation (see Figure 6.4). Most aggression presented by P727 occurred week 2 of the initial control phase. P727 presented aggressive behaviour in four observations during the intervention, of which three were below 2 percent and one (week 15) was below 9 percent. No aggressive behaviour was observed during the final 2 weeks of the intervention to the final observation week 23.

Figure 6.4 shows hyperactive behaviour presented by P727 decreased slightly during the pre-intervention control phase, and decreased further from 30 to an average of approximately 7 percent in the final weeks of the intervention phase. Hyperactive behaviour reached 0 percent on week 19 in which P727 missed a

session, and remained at approximately 5 percent throughout the post-intervention control phase.

P727's inattentive behaviour remained below 15 percent throughout the 24 weeks, with the exception of week 6 in which inattentive behaviours reached 86 percent. Excluding this latter point, data from Figure 6.4 indicate a slight decrease in inattentive behaviours presented by P727 across the pre-intervention control. Initial observations in the intervention phase indicate a further decline in such behaviours. Inattentive behaviours increased slightly during week 15, but again decreased to 0 percent before week 17. Similarly as for aggression, inattentive behaviours presented by P727 remained infrequent during post-intervention observations.

The percentage of impulsive behaviour presented by P727 (Figure 6.4) varied between 0 and 20 throughout. Impulsive behaviour decreased slightly during the initial control phase and, with the exception of week 13, decreased during the intervention, particularly in the final 3 weeks. With the exception of week 20, impulsive behaviour remained below 2 percent during the post-intervention control.

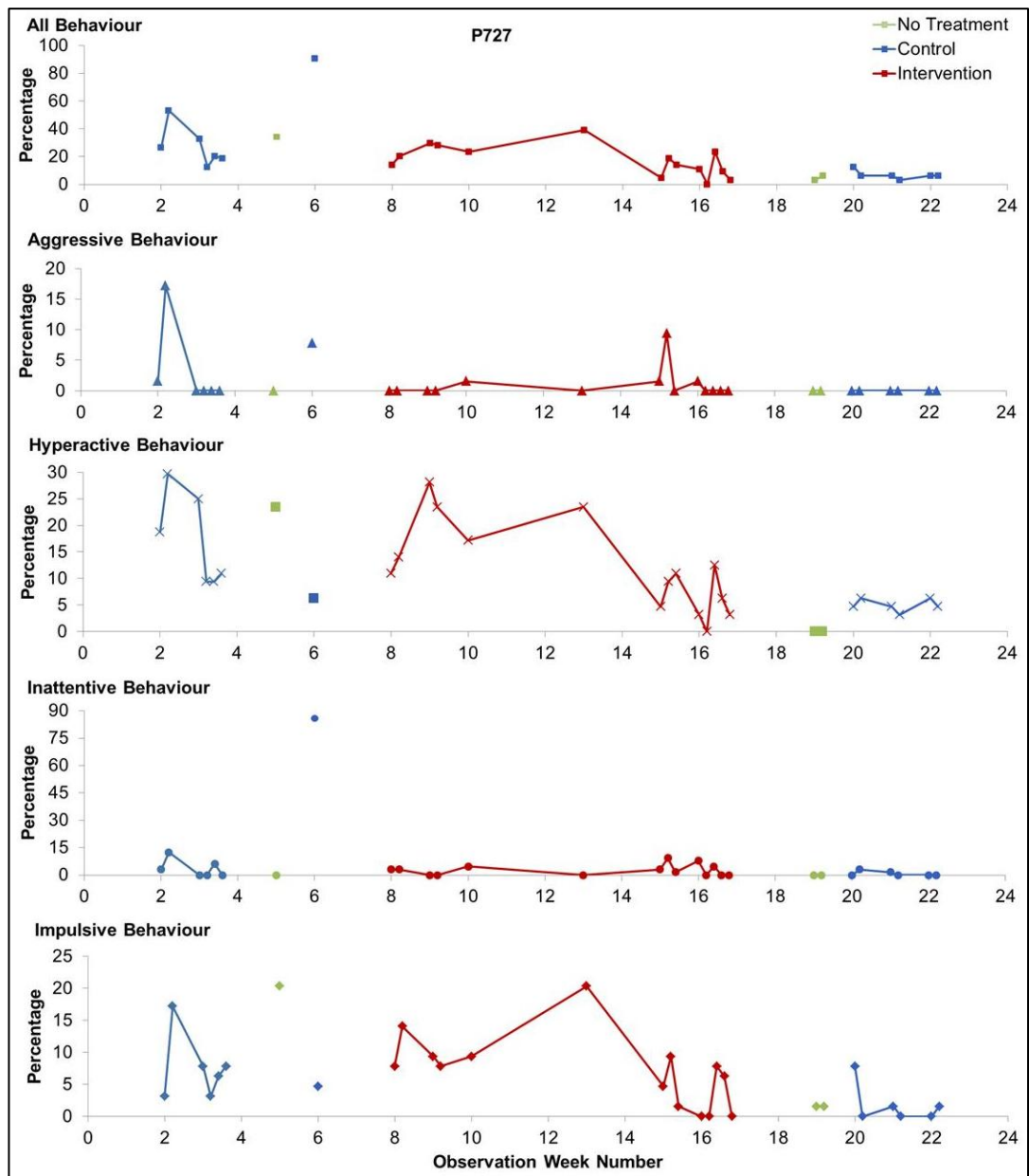


Figure 6.4 Percentage of target behaviour observed for P727.

Participant 622 was observed for a total of 432 minutes, of which 40 minutes were observed prior to the baseline measure, 96 minutes were during the initial control phase, 152 minutes of observations were conducted during the intervention phase, and 144 minutes were observed after the intervention from week 20. 68 percent of observations were conducted in English lessons, of which 64 percent were taken by the same teacher. The remaining 32 percent of

observations for P622 were conducted in Asdan and PSHE lessons, of which 25 percent were taught by the class tutor.

The percentage of All Behaviour presented by P622 varied from 3 to 81 percent throughout the 24 weeks. As can be seen from Figure 6.5, P622 presented between 20 and 31 percent of all target behaviour in initial baseline observations. Target behaviour continued at approximately 20 percent in week 3 and increased to 60 percent during the pre-intervention control phase. Throughout the mindfulness intervention (weeks 9, 13, 14 and 16) the percentage of all behaviour presented by P622 gradually decreased to below the initial baseline phase of 20 percent. Following intervention the percentage of all behaviour varied. Week 20 behaviour increased to 81 percent followed by a decrease to 3 percent. Behaviour gradually increased to a similar percentage observed at initial baseline. The percentage of all behaviour was consistent with delay tolerance data in which impulsivity increased at pre-intervention and decreased at post-intervention.

Data in Figure 6.5 indicate that the percentage of aggressive behaviour presented by P622 was below 10 percent during the initial baseline and week 3 of the initial control phase. Aggressive behaviour increased to 25 percent on week 5 of the pre-intervention control phase and then gradually decreased in the following 3 weeks of observations. The first week of the intervention phase P622 presented 11 and 12 percent aggressive behaviour, which decreased to zero on weeks 14 and 16. Although on two occasions (weeks 20 and 23) P622 presented 11 and 12 percent of aggressive behaviour, this behaviour generally remained infrequent following the intervention phase.

Hyperactive behaviour presented by P622 (Figure 6.5) increased from no occurrence on week 2 to more than 30 percent on week 9, however, during the intervention hyperactive behaviour decreased. Post-intervention, baseline observations gradually returned to 36 percent as observed in week 9. Inattentive behaviour varied between zero and 72 percent throughout the 24 weeks. P622 presented below 20 percent of inattentive behaviour at initial baseline and control phases, except on weeks 5 and 7 in which inattention increased above 40 percent. Throughout the intervention, P622 presented few inattentive behaviours, the most (12 percent) being presented on week 14. Post-intervention, inattentive behaviour presented by P622 increased on week 20 to 72 percent, then decreased to below 2 percent during week 23.

P622's impulsive behaviour (Figure 6.5) varied from 0 to 40 percent. Impulsive behaviour increased during the pre-intervention control phase and gradually decreased across the intervention phase. Impulsive behaviour increased on week 20 post-intervention, but decreased gradually to below the percentage of impulsive behaviour initially observed for P622. Generally, P622's target behaviours increased during pre-intervention control and decreased to below the percentage of undesirable behaviour observed at initial baseline.



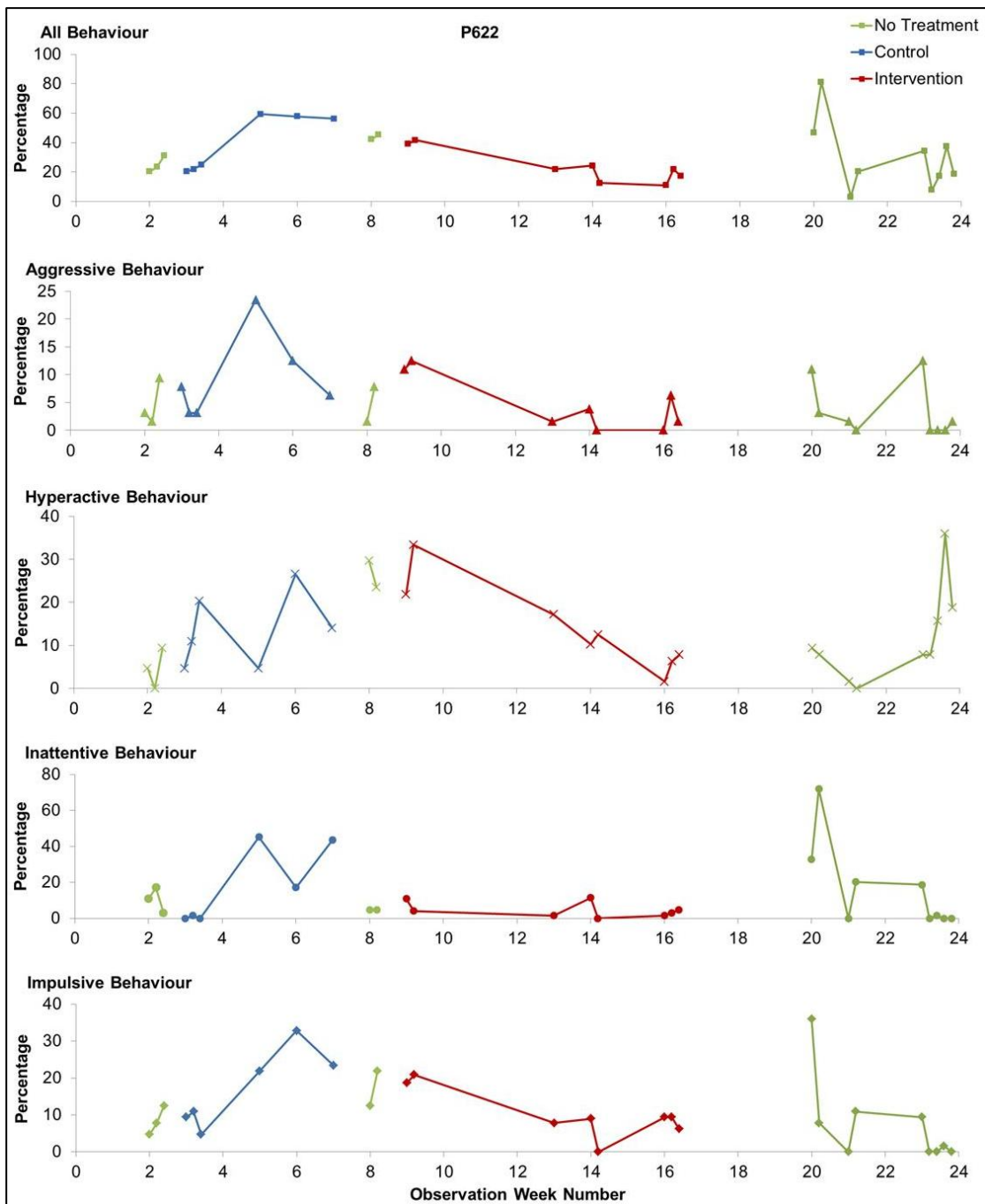


Figure 6.5 Percentage of target behaviour observed for P622.

P2117 was observed for a total of 464 minutes, of which 40 minutes were during the initial baseline, 112 during the pre-intervention control phase, observations during the intervention phase totalled 152 minutes and 160 minutes were conducted in the post-intervention baseline. Seventy percent of the observations were conducted in English lessons, of which 60 percent were

taught by the same teacher, and 30 percent were in Asdan and PSHE lessons (23 percent taught by the class tutor).

Data from Figure 6.6 present similarities with observation data for P622 in Figure 6.5 in which the percentage of All Behaviour slightly increased during the pre-intervention control, decreased during the intervention, and at post-intervention behaviour increased at week 20 then decreased in remaining observations. P2117 presented infrequent aggressive behaviour throughout the 24 weeks, the majority of which occurred during initial baseline, pre-intervention control and the first week of the intervention phase (63 percent week 9). After week 9, aggressive behaviour remained below 5 percent during the intervention and post-intervention observations.

Again, similarly to P622, hyperactive behaviour presented by P2117 ranged from 0 to 36 percent throughout the observations, the majority of which occurred between weeks 2 and 10. Hyperactive behaviours slightly decreased during the pre-intervention control then increased from 13 to 30 percent in the first two intervention weeks. However, after weeks 11 and 12 (Easter break) hyperactive behaviour declined to below 10 percent for the remaining intervention phase, with the exception of week 16. Post-intervention, data in Figure 6.6 show P2117's hyperactive behaviour increased on week 17, returned to below 5 percent on week 20, but then increased gradually in the final observations to a point similar to that in initial observations.

With the exception of week 9, P2117's percentage of inattentive behaviour in Figure 6.6 is similar to P622 (see Figure 6.5). Inattention increased throughout

baseline and pre-intervention control to 69 percent on week 9. During the intervention, P2117's inattentive behaviour decreased to 2 percent on week 16. Infrequent inattentive behaviour was maintained during post-intervention, except for week 20 where P2117's inattention increased to 48 percent (as similar for P622, Figure 6.5). Similarly to inattentive behaviour, impulsive behaviour initially increased followed by a reduction to almost 0 percent from weeks 10 to 23. Generally, data from Figure 6.6 suggest target behaviour decreased throughout the intervention phase and remained lower than the percentage observed at initial baseline following mindfulness training.

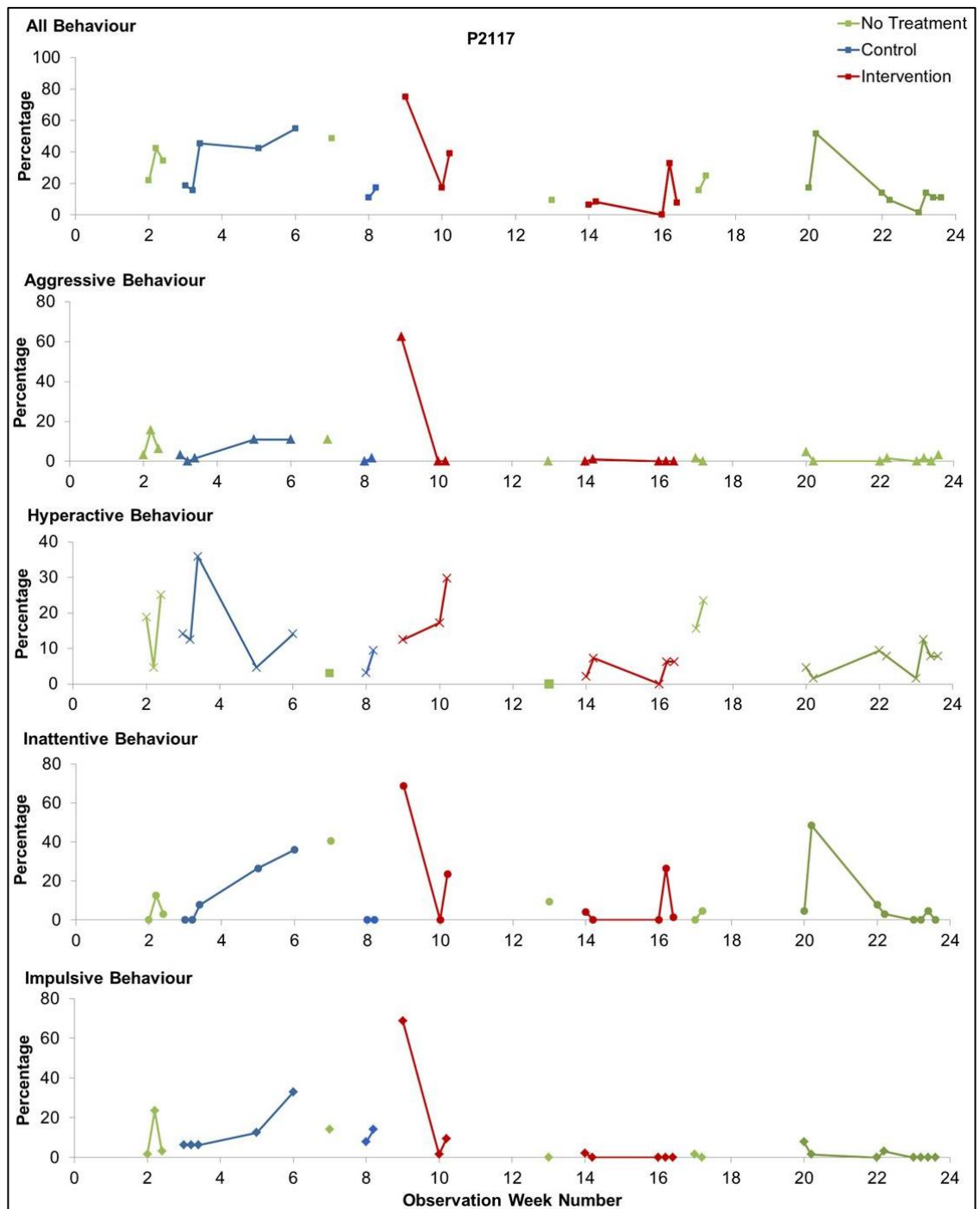


Figure 6.6 Percentage of target behaviour observed in the classroom for P2117.

P1415 was observed in lessons for a total of 516 minutes of which, 96 minutes were in the pre-intervention baseline phase, 96 minutes during the initial control weeks 5 to 8, 188 minutes were observed during the intervention, and 136 minutes were conducted during the post-intervention baseline. Sixty-five

percent of observations were in English lessons, of which 62 percent were taught by the Literacy teacher. Due to a change of class on week 13, the remaining 35 percent of lessons observed were taught by a different teacher, of which 67 percent were Maths lessons and 33 percent were Science, Asdan and PSHE lessons.

It is important to consider the change in class on week 13 (made in an attempt to improve P1415's behaviour at school) in analysis of classroom observation data. As evident in Figure 6.7, the percentage of observed behaviour presented by P1415 increased and continued until week 13 in which a substantial reduction in undesirable behaviour was observed. The percentage of All Behaviour presented by P1415 was constant during the initial baseline at approximately 44 percent. During weeks 5 to 7 behaviour increased to 70 percent then decreased to below 60 percent on week 8. The percentage of all behaviour decreased throughout the intervention to 14 percent on week 16 and, although P1415 presented increased behaviour immediately after the intervention, behaviour gradually decreased to 3 percent in the final observation.

Figure 6.7 shows aggressive behaviour was initially low at baseline and increased to 39 percent on week 9 of the intervention. However, during intervention and post-intervention baseline, aggressive behaviour decreased to 0 percent, as observed at initial baseline. Hyperactive behaviour increased slightly during baseline to 44 percent on week 6 of the control phase. After week 9, P1415's hyperactivity decreased and remained below 20 percent during the intervention. P1415 presented increased hyperactive behaviour (55 percent) in

initial post-intervention observations however this decreased rapidly to 0 percent in the final observation week 23.

Similarly to aggressive behaviour, inattentive behaviour presented by P1415 (Figure 6.7) was uncommon initially then increased from week 6 to 9. Inattentive behaviour returned to zero by week 16 of the intervention, and remained below 8 percent throughout the post-intervention baseline, with the exception of week 19. Impulsive behaviour increased across initial baseline and the pre-intervention control and during the intervention returned to a point similar to week 1. Impulsive behaviour continued to decrease post-intervention to zero in the final observation.

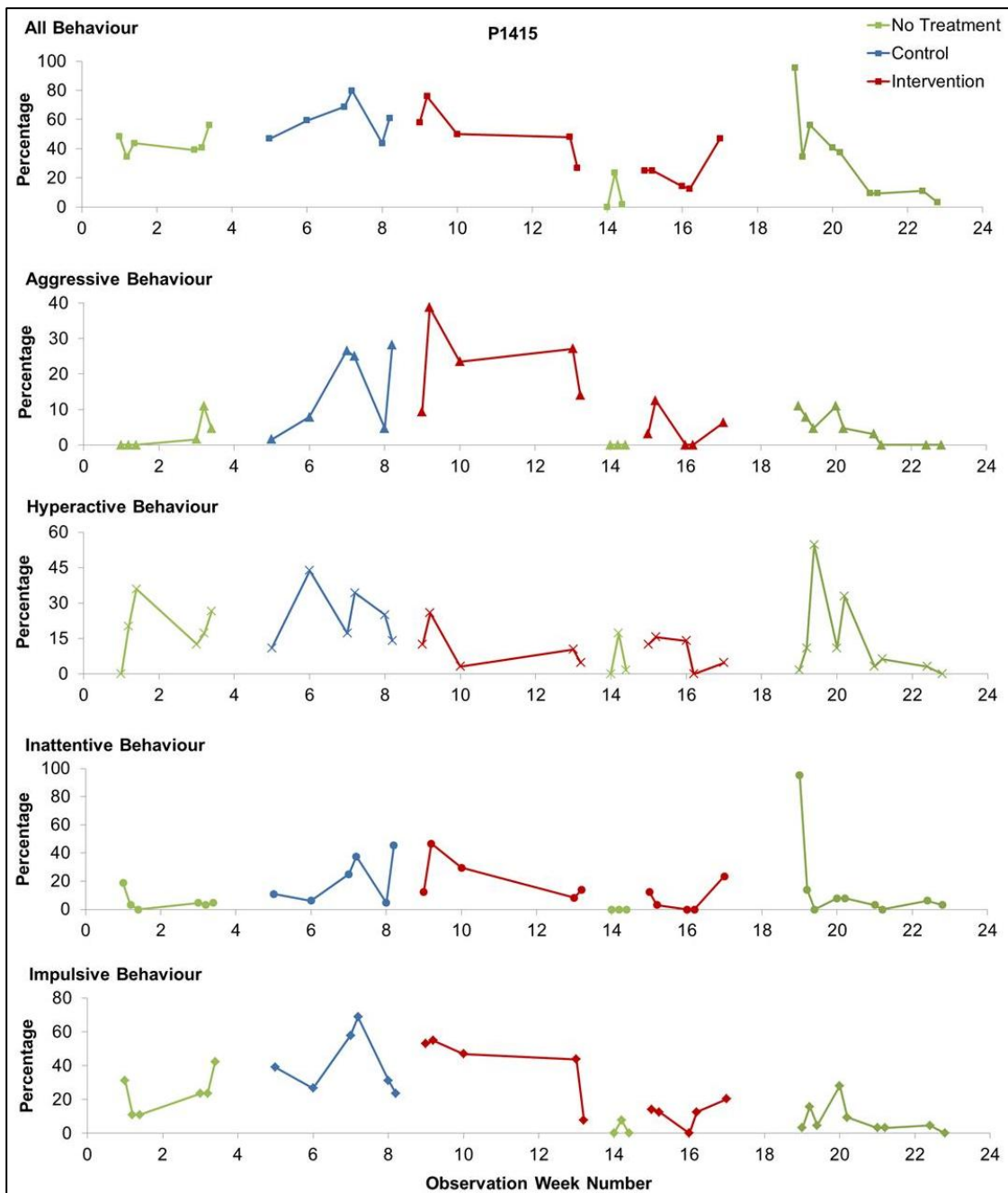


Figure 6.7 Percentage of target behaviour observed for P1415.

P411 was observed for a total of 528 minutes throughout the 24 weeks. Ninety-six minutes of observation were conducted during the baseline phase, during the pre-intervention control phase 96 minutes were observed, 256 minutes were observed throughout the intervention phase and the final 80 minutes were observed in the post-intervention control phase. Of these, 82 percent were

conducted in English lessons and were taught by one Literacy teacher. Maths and Science lessons taught by one maths teacher and one science teacher made up the following 18 percent of observations.

As evident in Figure 6.8, P411 presented less than 13 percent of All Behaviour during initial baseline observations. Throughout the pre-intervention control behaviour increased to 31 percent on week 6 initially, but decreased to 3 percent in week 8. During the intervention the percentage of all behaviour observed decreased from 23 percent on week 9 to below 2 percent on week 16. During week 19 in which P411 missed a session, behaviour increased to 11 and 25 percent. P411's percentage of all target behaviour returned to 7 percent during the last intervention week. Behaviour remained infrequent, but slightly increased throughout the post-intervention control to a percentage similarly observed at the pre-intervention baseline. The percentage of All Behaviour for P411 mainly entailed hyperactive behaviours, as Figure 6.8 shows a similar occurrence of Hyperactive and All behaviour across the 24 weeks.

Throughout the 24 observation weeks, P411 presented only 2 percent of aggressive behaviour in week 8 of the pre-intervention control phase. The percentage of inattentive behaviour presented by P411 was below 3 percent throughout the initial baseline phase, however increased during the pre-intervention control from week 6 to week 8. During the intervention no inattentive behaviour was observed from week 9 to 16 and inattentive behaviour remained infrequent with the exception of weeks 19, 20 and 22, in which inattentive behaviours remained below 8 percent. Similar observations were recorded for



impulsive behaviours, although Figure 6.8 shows a decrease in impulsive behaviours during and after the intervention.

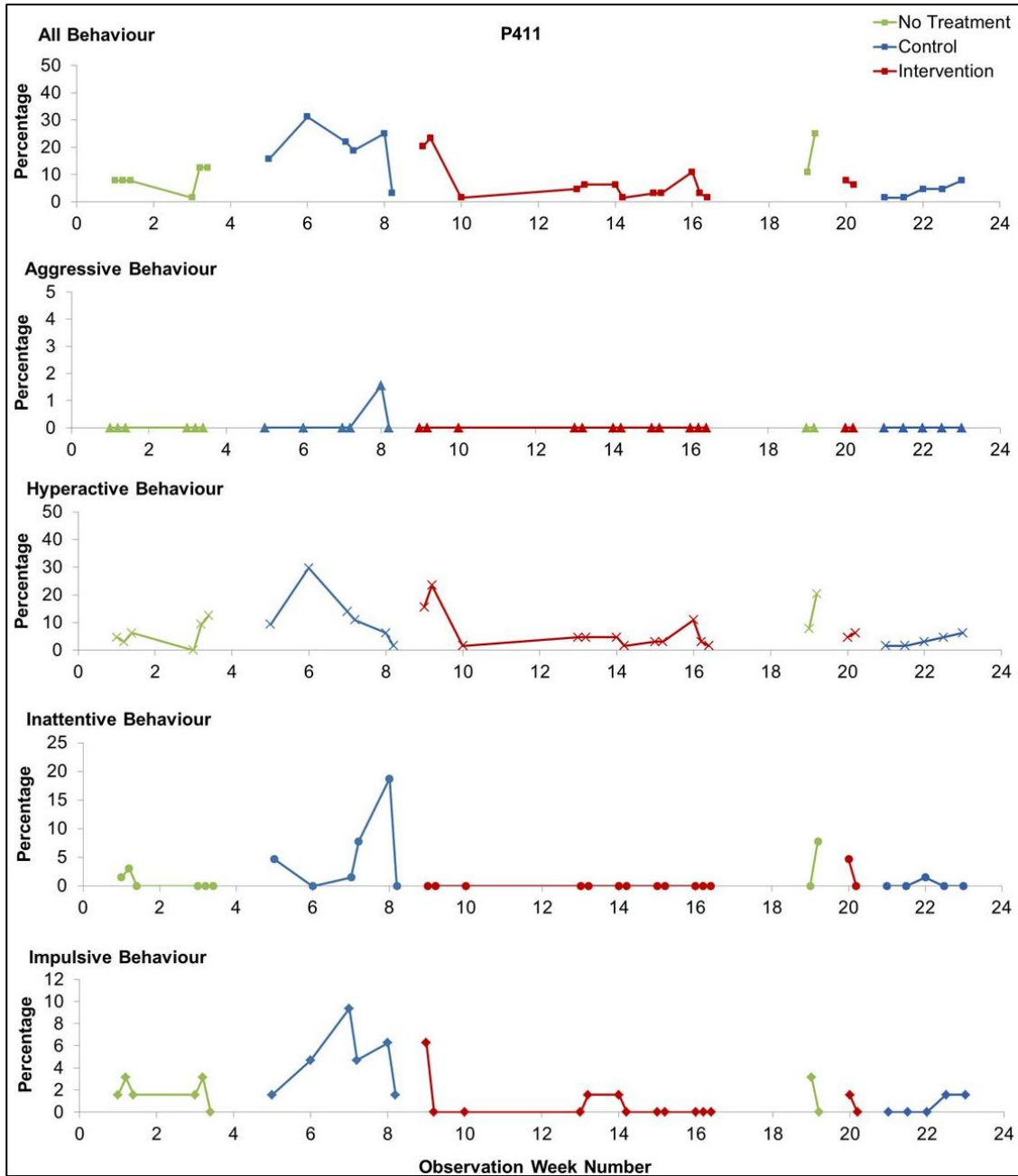


Figure 6.8 Percentage of target behaviour observed for P411.

### **6.3.3 Sand timer choice task in school (SCTs)**

As can be seen from Figure 6.9, P1417 tolerated the 30 second delay at all measures, but varied his tolerance of other delays. Typical discounting was produced in the initial baseline SCT whereby P1417 discounted more as the delay to the LL reward increased from 30 to 120 seconds. Although P1417 initially discounted the 120 second delay he proceeded to tolerate the 120 and the increased delays of 150 and 180 seconds at pre-intervention. Discounting varied greatly between phases with complete toleration of all delays at pre-intervention and follow-up, but showed increased discounting at post-intervention. This participant verbally reported that he was saving for an Xbox and game at the time of the pre-intervention and follow-up measures which may account for his high tolerance at these points.

P727 tolerated all 30s, 120s, 150s and 180s (seconds) delays presented to him at each stage in the design (Figure 6.9), indicating that P727 made highly self-controlled choices in the SCTs. P622 tolerated delays of 30 and 120 seconds in the SCTs initial baseline measure, but discounted the additional delays of 150 and 180 seconds at a far greater rate (Figure 6.9). P622 continued to tolerate the initial 30 second delay at the pre-intervention measure, but presented increased discounting at the 120 and 180 second delays, indicating a slight increase in impulsive responding after the initial control phase. Indifference points at post-intervention show continued tolerance of the 30 second delay and increased tolerance of the 120 and 180 second delays suggesting an increase in self-controlled choice responding following the mindfulness-based training intervention.

Data displayed in Figure 6.9 show that the discounting rate for P2117 increased across each SCTs measure throughout the 16 week program as IPs for each delay decreased. During the baseline measure, P2117 discounted the 10p LL reward at 7.4 for the 30s (second) delay, 5.4 for the 120s delay, and 7.6 for the 150s additional delay (P2117 refused the 180s delay). At pre-intervention, P2117 tolerated the initial 30 second delay, but discounted all LL rewards at 120 and 180 second delays. The rate of discounting increased post-intervention with P2117 obtaining an IP of 5.1 in the 30 second delay, indicating an increase in impulsive choice across measures.

At the baseline SCTs measure, P1415 produced typical discounting whereby he discounted the LL reward more rapidly as the delay to it increased (see Figure 6.9). P1415's delay tolerance increased following the initial control phase to indifference points (IP) of 9.5 for each delay. At post-intervention P1415 presented reduced tolerance of all delays, indicating increased impulsive choice following the intervention.

Figure 6.9 indicates that P411 discounted the LL reward more rapidly as the delay increased from 30s to 120s (seconds) at the initial baseline measure. P411 presented increased tolerance of the additional 150s and 180s delays, but still showed some discounting as the delay increased to 180s. P411 presented no discounting of delays at pre- and post-intervention and follow-up measures, and hence increased toleration following initial baseline.

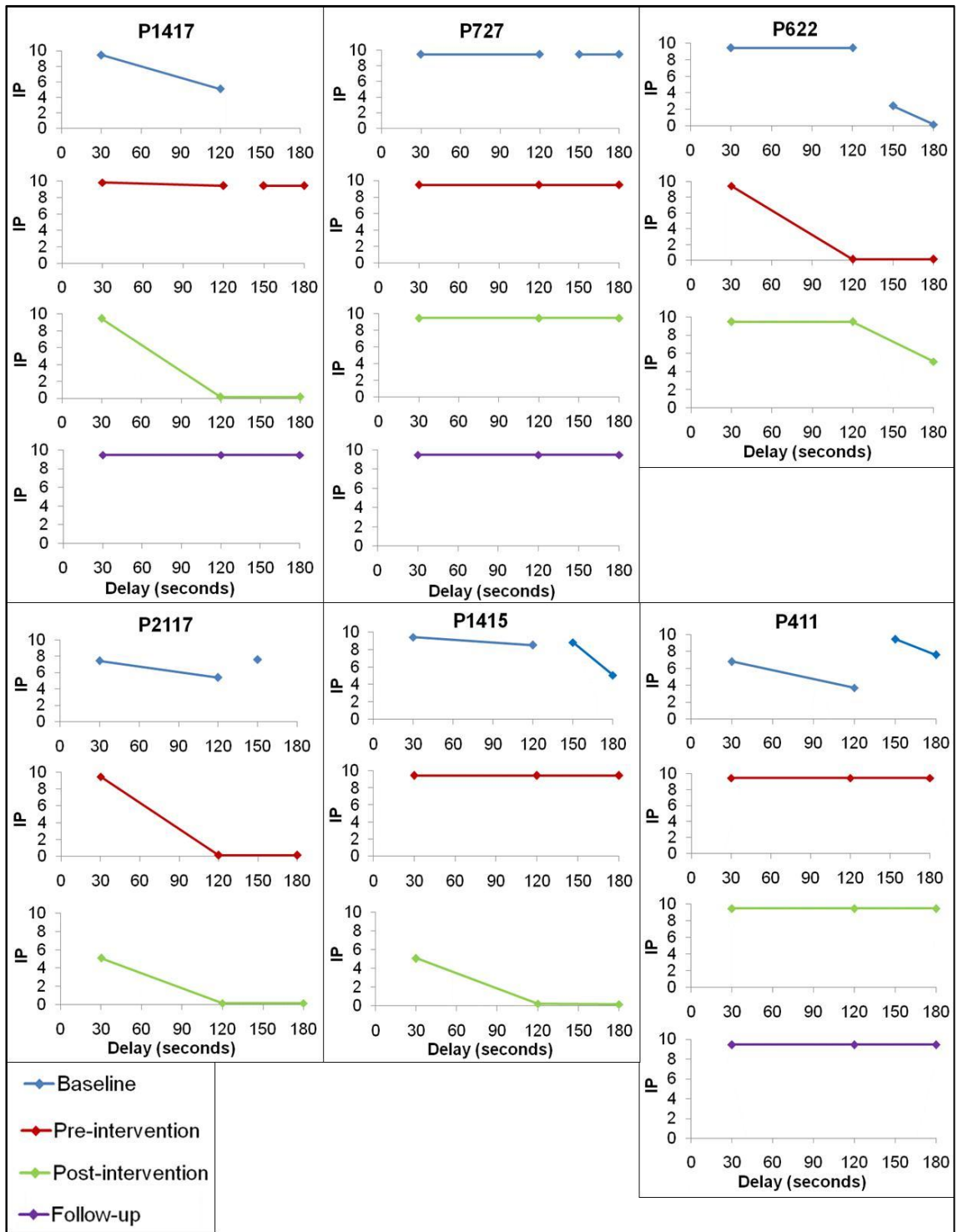


Figure 6.9 Indifference point (IP) curves produced by each participant at each stage of the intervention.

### **6.3.4 Progressive Delay Task (PDT)**

Figure 6.10 shows the largest delay tolerated by P1417 in the PDT was 153 seconds at pre-intervention. As for Figure 6.9, he was more tolerant of longer delays in pre-intervention and follow-up (102 seconds), possibly due to him saving money at the time of these tasks. Data from Figures 6.9 and 6.10 indicate consistency between the PDT and SCTs as measures of delay tolerance. However, the intervention did not result in an increase in delay toleration for this participant as least tolerance occurred after the intervention (68 seconds).

Similar to IPs produced in the SCT, evidence of self-controlled responding was presented by P727 in the PDT (Figure 6.10) in which he tolerated 518s (seconds) at pre- and post-intervention, followed by an increased toleration of 777s at follow-up. Once again, similar to delay tolerance in the SCTs, data from the PDT for P622 (in Figure 6.10) indicate an increase in tolerance of delay following the intervention phase in which P622 tolerated 45 seconds at pre-intervention and 102 seconds post-intervention.

The delays tolerated by P2117 on the PDT (Figure 6.10) decreased from 102 seconds at pre-intervention to 45 seconds at post-intervention indicating increased impulsive choice responding. Figure 6.10 shows a decrease in delay tolerance for P1415 from 68 seconds at pre-intervention to 45 seconds post-intervention in the Progressive Delay Task (PDT). P411 presented increased tolerance of delays following the mindfulness intervention from 102s at pre-intervention to 242s post-intervention. However, tolerance to delays at follow-up decreased slightly to 230s following the post-intervention control. Across

participants, similar results were obtained from the PDT and the SCTs suggesting consistency between measures.

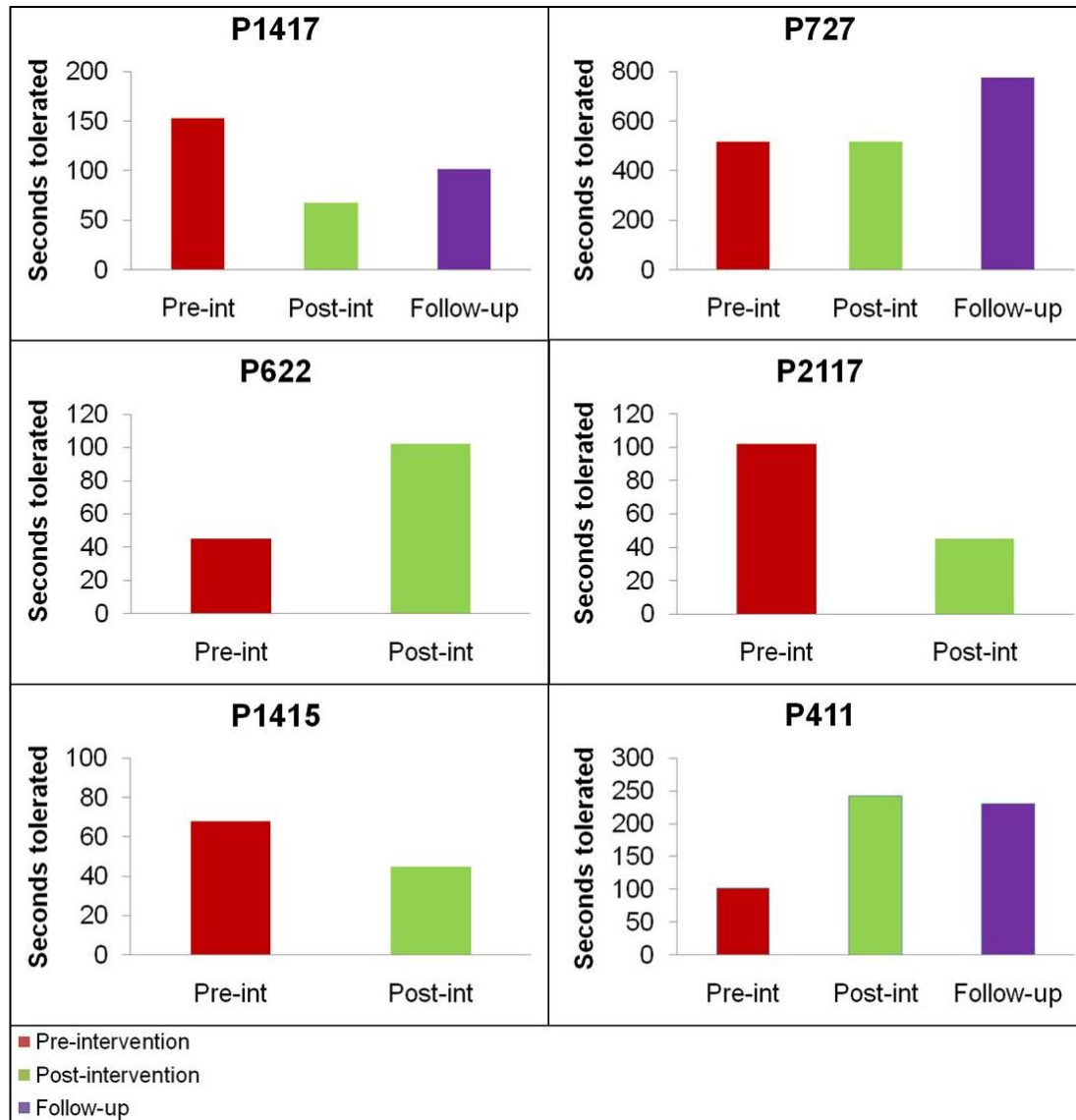


Figure 6.10 The largest delays (in seconds) tolerated in the Progressive Delay Task (PDT).

### 6.3.5 Self-report measures

The scores of each questionnaire for P1417 in Figure 6.11 suggest higher impulsivity scores on the Junior I.6 coincided with low mindfulness scores on the CAMM at baseline and post-intervention. Scores obtained on the Junior I.6

increased slightly across baseline, pre- and post-intervention phases, but dropped dramatically at follow-up. This large decrease in impulsivity was consistent with the increase in delay toleration in the SCTs and the BSCS score at follow-up. Scores on the BSCS increased suggesting increased self-control across measures, with the smallest increase pre- to post-intervention. Scores obtained on the CAMM and MAAS generally decreased slightly across measures.

Questionnaire scores obtained from P727 (Figure 6.11 below) remained at approximately 60 percent on the Junior I.6 and the BSCS throughout the 16 week program. Scores obtained from the CAMM slightly decreased across measures. P727 scored approximately 40 percent on the MAAS at baseline and pre-intervention however, this increased to 60 percent after the intervention and reduced slightly to 58 percent at follow-up.

Scores obtained by P622 for all scales (Figure 6.11) generally decreased across measures with highest scores for P622 occurring at baseline and lowest scores at post-intervention. The BSCS differed slightly with P622 scoring approximately 55 percent at pre- and post-intervention.

Questionnaire scores for P2117 illustrated in Figure 6.11 indicate relatively high scores on the Junior I.6 Impulsivity scale which were reflected in lower scores on the CAMM. For example, following the control phase the Junior I.6 score increased from 78 at baseline to 91 percent. In contrast, the CAMM decreased from 45 at baseline to 41 percent at pre-intervention. Post-intervention scores for the Junior I.6 decreased to 83 percent and increased to 45 percent for the

CAMM indicating decreased impulsivity and increased mindfulness post-intervention. Scores obtained on the BSCS remained relatively constant across measures at an average of 57 percent and scores on the MAAS decreased across measures from 53 to 40 percent. Scores obtained on the MAAS were consistent with the decrease in P2117's delay tolerance in the SCTs and PDT.

Questionnaire scores achieved by P1415 are also available in Figure 6.11. Scores on the Junior I.6 gradually increased across measures from 83 percent at baseline to 96 percent post-intervention. Scores obtained on the Junior I.6 were consistent with the increase in impulsive choice responding in the SCTs and PDT. Percentage scores on the BSCS and MAAS fluctuated similarly and correlated with measures of delay tolerance in the SCTs and PDT. Scores obtained from the CAMM indicate P1415 reported slightly increased mindfulness from 44 percent at baseline to 52 percent post-intervention. Although CAMM and Junior I.6 scores similarly increased suggesting no correlation between mindfulness and impulsivity, Figure 6.11 illustrates a substantial difference between high scores obtained on the Junior I.6 and lower scores obtained on the remaining three self-reports.

Scores obtained from questionnaires in Figure 6.11 suggest P411 reported decreased impulsivity on the Junior I.6 from 74 percent at baseline to 26 percent at follow-up. On the other hand, P411's scores on the CAMM slightly increased from 56 percent at baseline to 69 percent at follow-up. BSCS scores for P411 increased by 17 percent following the mindfulness intervention, and reduced slightly at follow-up. MAAS scores remained relatively similar throughout with the highest score of 64 percent obtained at follow-up.



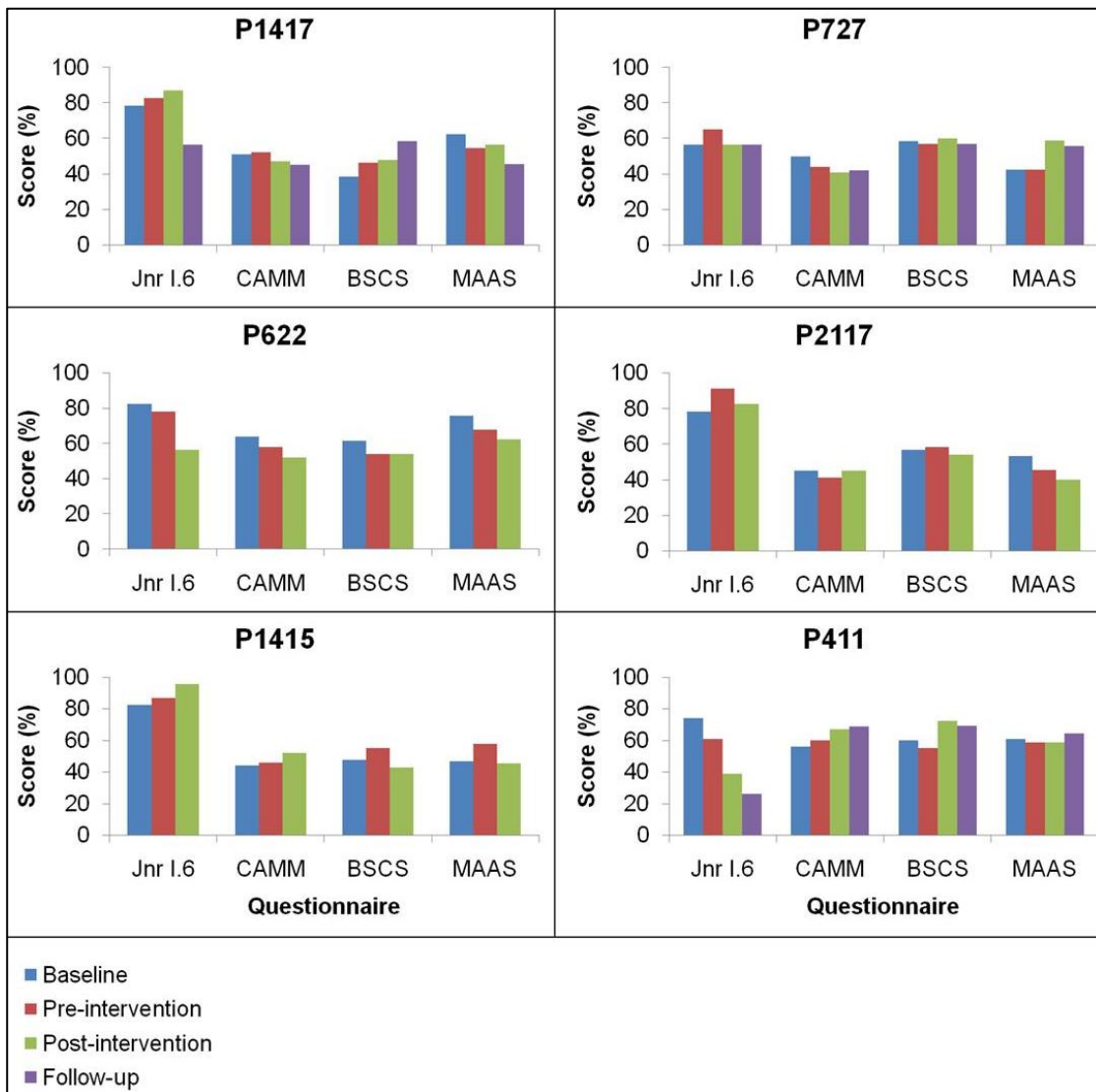


Figure 6.11 Questionnaire scores obtained across each phase for each participant.

### 6.3.6 Staff impulsivity ratings (SIR)

Staff ratings of general impulsivity in school (see Figure 6.12) varied between staff initially, with more consistent scoring at post-intervention and follow-up. Staff 1 (S1) reported a gradual decrease in impulsivity for P1417, staff 2 (S2) rated P1417 to have decreased impulsivity at pre-intervention from 5 to 3 which then increased to a rating of 4 post-intervention and follow-up. On the other

hand, staff 3 (S3) assigned a rating of 5 at baseline which increased to 7 pre-intervention, but decreased to a score of 6 (higher than initial baseline rating) post-intervention and follow-up.

Staff ratings of general classroom impulsivity for P727 in Figure 6.12 were reasonably consistent between staff. Figure 6.12 shows a slight decrease in impulsivity ratings by staff following the intervention, which remained similar at follow-up. Ratings from staff 2 in particular mirror scores P727 obtained on the MAAS, whereby high impulsivity ratings coincide with lower MAAS scores at baseline and pre-intervention measures, and vice versa at post-intervention and follow-up.

Figure 6.12 indicates that, similarly to P727, ratings of general impulsivity in school were reasonably consistent between staff. Consistent with delay tolerance in the SCTs and PDT, staff 2 and staff 3 rated P622's impulsivity as highest following the pre-intervention control phase then lower following the mindfulness intervention phase. However, staff 1 rated P622 to have moderately decreased impulsivity across measures.

Staff ratings of P2117's general impulsivity were similar at baseline and post-intervention for all staff (Figure 6.12), but staff ratings were highly variable at pre-intervention with scores of 2, 6 and 9. Staff 1 rated P2117 to present less general impulsivity from 7 at baseline to 2 following the control phase and increased impulsivity post-intervention to 7, slightly below the initial baseline rating. Staff 2 reported relatively stable ratings across each measure. However, consistent with Junior I.6 and CAMM scores, staff 3 reported an increase from 8

(baseline) to 9 (pre-intervention), with a slight decrease post-intervention. Baseline and post intervention data in Figure 6.12 indicate a slight reduction in staff reported impulsivity.

Staff ratings of general impulsivity at school (Figure 6.12) suggest that P1415 presented high levels of impulsivity, consistent with high scores obtained on the Junior I.6 impulsivity scale (Figure 6.11). However, impulsivity ratings by staff followed a similar trend whereby scores generally remained stable from baseline to pre-intervention and decreased at post-intervention. Figure 6.12 indicates that the pre-intervention control had no effect on staff ratings, but slightly decreased impulsivity ratings were given post-intervention.

Staff ratings in Figure 6.12 indicate that staff 3 rated P411 as having slightly increased impulsivity following the pre-intervention control. Staff 1's ratings correlated with scores obtained in the BSCS, whereby P411 reported decreased self-control following the pre-intervention control and increased self-control post-intervention. In contrast to staff 3's ratings, but consistent with delay tolerance data, staff 2 rated P411 to have decreased impulsivity from baseline to follow-up.

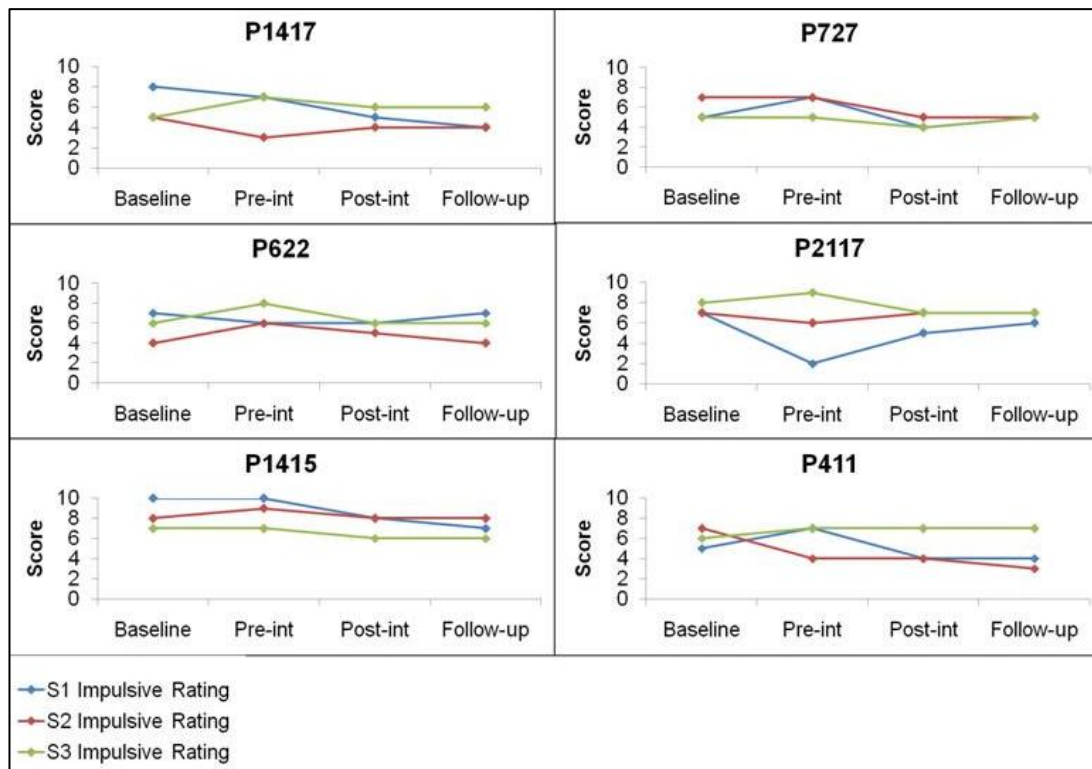


Figure 6.12 Staff ratings of general impulsivity in school for each participant.

### 6.3.7 Lesson attendance

Figure 6.13 below shows the percentage of full attendance to lessons for participants across the school year. As can be seen, P1417 had generally high attendance to lessons, with a slight increase from the autumn to spring school terms (weeks -16 to the first week of the present study). The percentage of full attendance to lessons increased slightly across the initial control phase and P1417 maintained above 90 percent of full attendance to lessons on weeks in which he participated in mindfulness intervention sessions. Week 13 in which P1417 missed a mindfulness session full attendance decreased to almost 80 percent. P1417 continued to maintain above 90 percent full attendance to lessons during the post-intervention control phase.

Increased attendance to lessons was recorded (see Figure 6.13) for P727 during initial baseline, followed by a slight decrease in attendance in the initial control phase. During week 6 his attendance decreased to almost 60 percent. This could be compared with the highly inattentive behaviour that was similarly noted in Figure 6.4. Attendance generally increased during the intervention phase to 100 percent, with the exception of week 14, in which no observations for P727 were conducted due to inconsistent attendance to lessons. P727 maintained above 90 percent full attendance to lessons during the post-intervention control phase.

Participant 622's attendance to lessons (Figure 6.13) increased from 60 to 100 percent during weeks -16 to -3, and returned to 60 percent by week 3. Attendance varied from 70 to 100 percent during the control phase and increased during the first 2 intervention weeks (weeks 8 and 9). Attendance decreased to 80 percent weeks 13 and 14. However this was followed by an increase to 93 percent on his final intervention week. Attendance continued above 85 percent to post-intervention with the exception of week 22 where attendance dropped to 60 percent. Generally, Figure 6.13 suggests P622's attendance to lessons increased throughout the school year.

Full attendance to lessons varied between 60 to 100 percent for P2117 (see Figure 6.13). P2117's attendance generally increased weeks -16 to 2, but on week 3 this decreased to 52 percent. With the exception of weeks 3 and 16, P2117's attendance remained above 80 percent throughout the pre-intervention control and intervention and increased to above 95 percent on weeks 10 and 15 of the intervention.

As illustrated in Figure 6.13, P1415's percentage of full attendance to lessons increased slightly weeks -16 to -4. Attendance decreased prior to the pre-intervention control phase and although highly variable, continued throughout the pre-intervention control phase. During the intervention P1415's attendance increased slightly, with the exception of weeks 13 and 15. Following the intervention, attendance remained high with an average of 95 percent full attendance to lessons on weeks 19, 20 and 21. An incident that occurred the final night of week 21 resulted in the internal exclusion of P1415 during week 22 with continued effects into week 23 consequently causing reduced attendance on week 22. This was comparable to the increased impulsive responding at post-intervention on the SCTs, PDT and P1415's Junior I.6 score.

P411 varied in his percentage of full attendance to lessons especially during weeks -16 to 3 (Figure 6.13). Percentage of full attendance stabilised slightly and increased to between 86 percent and 100 percent during the pre-intervention control. During the intervention, P411's attendance increased to above 91 percent, with the exception of week 16. During the post-intervention control phase, P411's percentage of full attendance decreased to 73 percent.

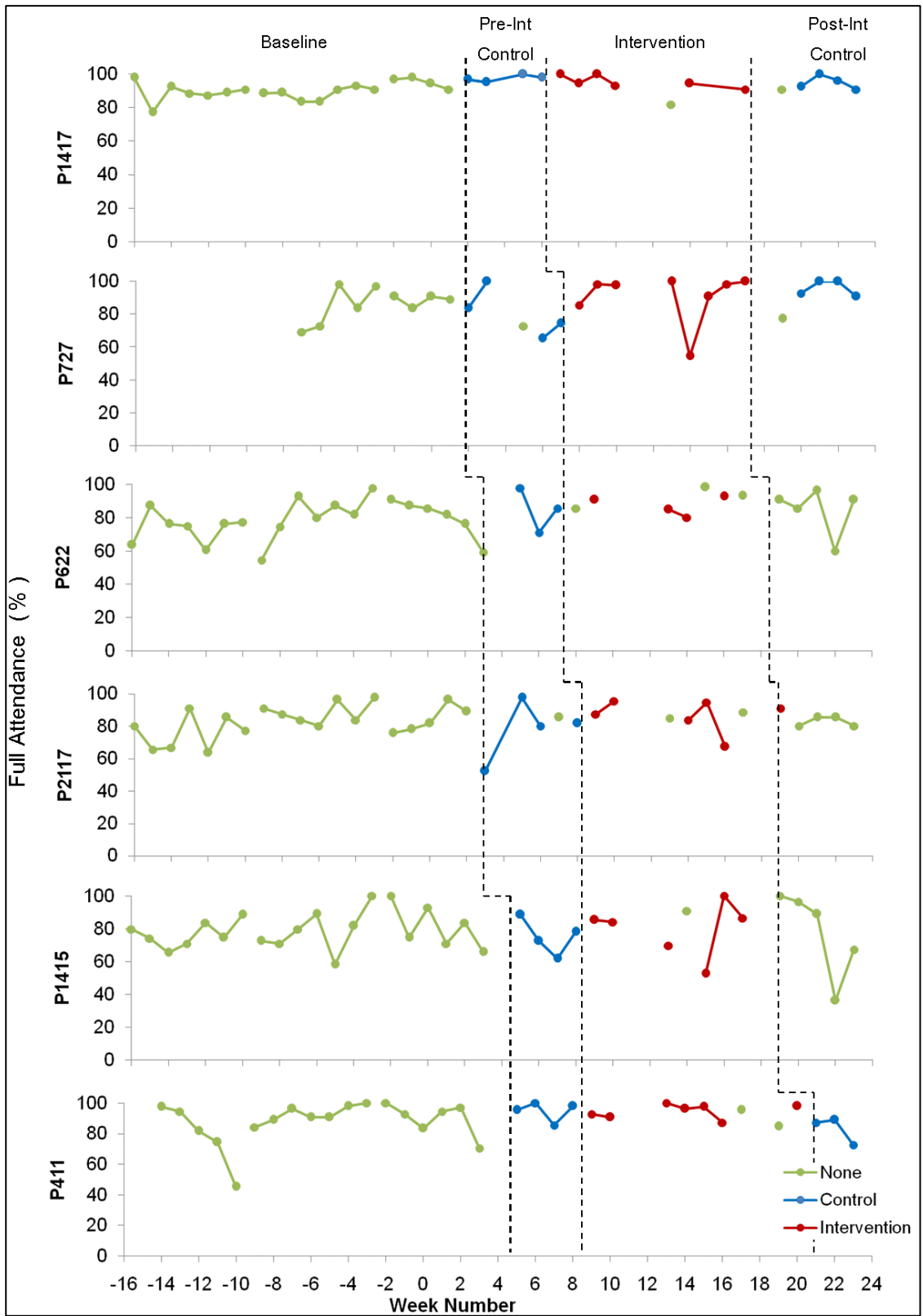


Figure 6.13 Percentage of full attendance to lessons from September 2008 to July 2009 for each participant.

### **6.3.8 Safety holds**

As can be seen in Figure 6.14, P1417 was held for safety four times throughout the school year, of which one occurred during initial baseline, two during the intervention phase, and the final hold was in week 19 in which P1417 missed a session. P1417 was held for safety prior to and after the post-intervention measure suggesting an increase in impulsivity at this point and a subsequent decrease at follow-up in which no holds occurred, as similar to results obtained from the SCTs and PDT. It could be suggested that weeks 19 and 16 were difficult weeks for P1417 with increased safety holds, low tolerance of delays at the post-intervention measure, no class attendance data available for week 16, and his percentage of total behaviour (Figure 6.3) slightly increased towards the end of week 16.

Data in Figure 6.14 show P727 was held for safety a total of four occasions during school and four in the house from September 2008 to July 2009. Two school holds occurred during the pre-intervention control phase (weeks 2 and 6) and two during the intervention (weeks 8 and 14). As mentioned previously, data obtained during weeks 6 and 14 suggest P727 may have been having difficulties at these particular times. Safety holds in the house occurred prior to and during the pre-intervention control phase indicating reduced holds during and after the intervention. P622 (Figure 6.14) was held once in school throughout the academic year, prior to the control and intervention phases in the current study.

The number of holds P2117 was involved in at school decreased from week -16 to 2, and remained stable during the pre-intervention control (see Figure 6.14).



During initial intervention holds in school slightly increased. However, holds decreased to zero in weeks 17 and 19 and continued to occur less often than reported at pre-intervention. Safety holds for P2117 in the house increased then decreased from weeks -16 to 3. Holds remained infrequent during the pre-intervention control, but increased slightly during the intervention. As in school, holds decreased after the intervention. Figures 6.13 and 6.14 suggest holds co-occurred with decreased attendance to lessons.

Holds for safety in school for P1415 decreased from a total of five on week -14 to zero on week 3 (see Figure 6.14). His number of holds in school increased slightly during the pre-intervention control phase, decreased during the 7 week intervention, with the exception of week 15, and P1415 was not held at school post-intervention. The total safety holds that occurred in the house increased throughout the initial baseline and decreased during the pre-intervention control. As similar to holds in school, holds in the house remained infrequent throughout the intervention, except for week 15, but increased substantially weeks 19 to 24.

Similarly to P2117, safety holds for P1415 appear inversely related to lesson attendance as generally, weeks in which attendance decreased, the number of holds increased. Furthermore, data suggests similarity between the decrease in delay tolerance from pre- to post-intervention (as measured in the SCTs and PDT) and the increase in holds in the house. As mentioned previously, it is important to note the occurrence of an incident in the house on the final night of week 21 in addition to the change of class in week 13 possibly accounting for various changes in behaviour. P411 was not held throughout the school year and as a result his data are not included in Figure 6.14.

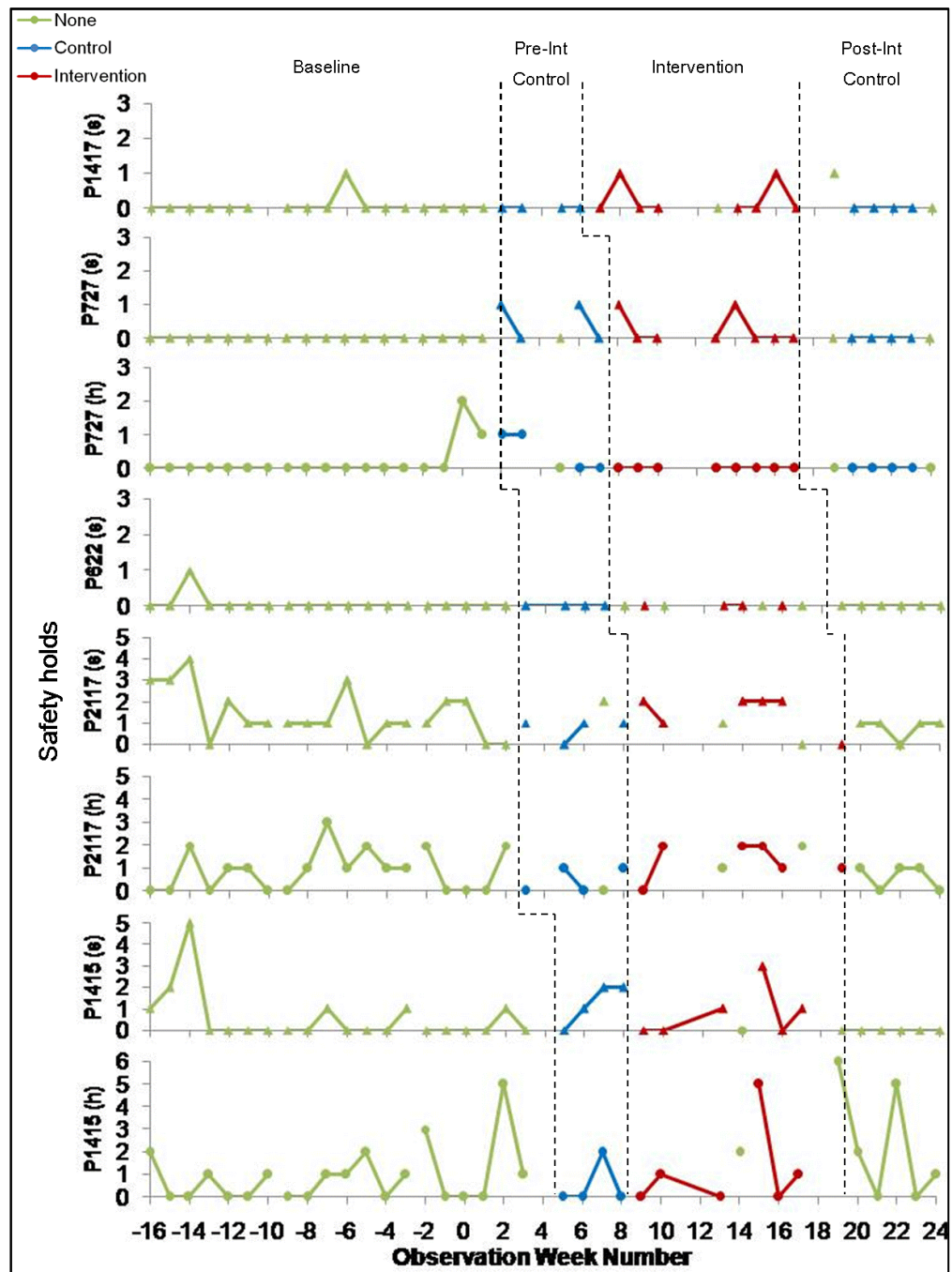


Figure 6.14 The total number of incidents each participant was involved in throughout the academic year.

### 6.3.9 Summary of results for each participant across measures

In summary, data for P1417 indicate reduced undesirable target behaviour in the classroom throughout the intervention, which continued through to follow-up. In parallel, two members of staff reported P1417 to present reduced

impulsive behaviour from baseline to post-intervention, which was maintained at follow-up. Although varied, attendance increased prior to involvement in Experiment 7 and remained high throughout the intervention. Safety holds were infrequent, but mostly occurred between weeks 16 and 19. Data suggest measures of delay tolerance were affected by P1417's saving behaviour during the time of testing, with no intervention effect. Scores obtained on the four questionnaires were inconsistent with other measures and each other, although P1417 reported increased self-control across measures.

P727 produced highly tolerant responding to delays in the SCTs and PDT. Undesired behaviours (mostly impulsive and hyperactive) decreased during the intervention and remained low post-intervention. Holds at school increased during pre-intervention control and intervention phases, but decreased in the house. Attendance generally increased during and after the intervention. Scores obtained from the questionnaires were unrelated to other measures and between themselves, with the exception of the MAAS which related to staff ratings, indicating P727 had increased mindfulness and less impulsivity after mindfulness training.

P622 presented slightly decreased undesirable target behaviour during the intervention, but behaviours gradually returned post-intervention. P622 was only involved in one safety hold and his attendance to lessons varied, but slightly increased throughout the school year. Questionnaire scores generally decreased across measures and P622 was more delay tolerant post-intervention indicating an effect of the intervention on measures of delay tolerance (SCTs and PDT).

P2117 presented decreased target behaviour during and after the intervention and, although varied, attendance increased during the intervention. Holds slightly increased during the intervention, but decreased post-intervention to below initial measures. Ratings by staff 3 and 1 indicated reduced impulsivity post-intervention, however, P2117 was less delay tolerant post-intervention. Scores obtained on the questionnaires indicated a negative relationship between the Junior I.6 and the CAMM, but were unrelated to other questionnaires and measures.

P1415 increased discounting of delays in the SCTs and PDT and scored high impulsivity, low self-control and lower mindfulness at post-intervention. Attendance was highly variable, but slightly increased across phases. Safety holds remained similar throughout the intervention for both school and house, however post-intervention holds in the house increased and holds in school decreased. Staff rated P1415 to have decreased impulsivity following the intervention and classroom observations indicated decreased undesirable behaviour throughout the intervention, which was maintained during post-intervention baseline.

Lastly, P411's attendance increased from pre-intervention baseline to the final intervention session, however decreased during post-intervention, and P411 was not held for safety during the school year. P411 generally presented increased delay tolerance in the SCTs and PDT and reported decreased impulsivity on the Junior I.6 and increased mindfulness (CAMM) and self-control (BSCS), as consistent with the decrease in impulsivity ratings by staff 1 and

staff 2. Similarly undesirable target behaviour decreased throughout the intervention, but appeared to return in the final weeks of the post-intervention control phase.

## **6.4 Discussion**

In support of initial predictions, results from Experiment 7 provide evidence to suggest a beneficial effect of mindfulness-based skills training in decreasing impulsive behaviour in the small sample of adolescents in the current study. In particular, undesirable classroom behaviour observed using the COC decreased in all participants from initial baseline to post-intervention. Classroom behaviour prior to the intervention remained relatively stable for most participants, therefore it could be argued that the mindfulness training decreased behaviour rather than effects of experimenter or time. Furthermore, four participants reported decreased impulsivity on the Junior I.6 and three participants reported increased mindfulness on the CAMM and MAAS following the intervention.

Staff generally rated participants to have equal or reduced impulsivity post-intervention compared to ratings at baseline and for the majority of weeks in which mindfulness sessions occurred attendance was greater than at baseline. Moreover, it could be argued that effects of mindfulness training continued after the intervention, as particularly evident in staff ratings and classroom observation data.

Results from the SCTs varied widely between participants, with a number of participants presenting high toleration of delays. Previous work in the present

project suggested that the delays initially selected would bracket participants' responding. However, as mentioned previously, difficulties were met, with surprisingly high tolerance of delays for participants 727 and 411 in particular, but low tolerance for participant 2117. In an attempt to successfully bracket delays and capture participants' highly varied choice responding, the additional measure of delay tolerance (PDT) was designed to determine how long participants would wait. Results obtained from the PDT were consistent with results obtained from the SCTs for all six participants, suggesting that both tasks measured the same construct.

It could be argued that these tasks were both highly affected by external variables such as current saving habits, boredom as a result of repeated testing and measures commonly administered last (such as the MAAS), participants' mood, time of day, in addition to previous and subsequent events surrounding the time of data collection. For example, P1417's fluctuating tolerance of delays in the SCTs and PDT were likely to have been the result of his increased desire to save money for an Xbox at the time of pre-intervention and follow-up measures. In addition, P2117 became less delay tolerant, possibly due to increased boredom across delay tolerance measures. Questionnaire responses are likely to have been similarly affected, for example P622's scores generally decreased across measures for all questionnaires and P2117's MAAS scores gradually decreased from baseline to post-intervention.

As evident from data in the present study, adolescents with emotional and behavioural difficulties often present highly varied behaviour so that extremes in behaviour in response to a range of external variables, such as peer influences,

are often recorded. For example, P2117 and P622 were in the same class during the present study and presented substantially increased undesirable behaviour in classroom observations weeks 19 and 20. Furthermore, as mentioned previously, P1415's undesirable classroom behaviour promptly reduced following his move to a different class during observation week 13. Consequences following the incident at the end of week 21 involving P1415 and P622 resulted in both participants being internally excluded for 3 days. It seems reasonable to propose this as a likely explanation for the reduction in attendance on week 22 for P1415 and P622, the increase in holds in the house for P1415, P1415's high impulsivity, low self-control and mindfulness (MAAS) questionnaire scores and his decreased tolerance of delays in the SCTs and PDT at post-intervention. However, this was inconsistent with P1415's staff ratings of decreased impulsivity and self-reported increased mindfulness on the CAMM throughout the 16 week program.

Although correlations between measures were inconsistent between and within participants, some relations between measures were apparent. For example, observation week 6 P727 presented increased undesirable target behaviour, was involved in a hold and had decreased attendance. Lesson attendance was inversely related to the total number of safety holds in school for P1415, P2117 and P727. For example, week 14 P727 received no classroom observations due to low attendance of below 60 percent and was involved in one hold. P411 presented increased delay tolerance in the SCTs and PDT, reported decreased impulsivity (Junior I.6) and increased mindfulness (CAMM) and self-control (BSCS) at post-intervention, decreased impulsivity in ratings by two members of

staff, and presented decreased undesirable behaviour (COC) throughout the intervention.

On the whole however, data provided no clear evidence to suggest correlations between measures, with the exception of the SCTs and PDT. Results indicated some evidence in support of a negative correlation between impulsivity and mindfulness for participants 411 and 2117 and a positive correlation between self-control and mindfulness for P411. P2117's Junior I.6 and CAMM scores were inversely related, but were inconsistent with data obtained from other measures and P1415's self-control scores on the BSCS were positively correlated with his scores on the MAAS. Participant 727's questionnaire scores were incompatible between themselves and other measures, with the exception of the MAAS which corresponded to staff ratings, indicating that he had increased mindfulness and less impulsivity following mindfulness training. P1417's questionnaire scores were inconsistent with all other measures and each other. As discussed in previous chapters, inconsistencies between self-reports and measures of discounting have been reported, possibly indicating the presence of a number of impulsivity constructs (Reynolds, Ortengren, Richards and De Wit, 2006).

The MAAS was added to the initial battery of tests in the present study to determine the reliability of the CAMM. Unlike the CAMM, the MAAS was not specifically designed for use with children, and consequently contained words that did not apply to experiences of a child and more sophisticated language than that of the CAMM. The principal experimenter therefore altered the following statement "I drive places on 'automatic pilot' and then wonder why I



went there" by replacing the word 'drive' with 'walk'. In addition, the MAAS required opposite scoring to the other questionnaires which may have confused participants. It is possible therefore that the MAAS produced unreliable data due to confusion with the scoring and the complexity of the language for each item as participants with special learning requirements may have difficulties understanding (although this was not mentioned by any of the participants during testing).

Furthermore, participants' diagnoses may have influenced behaviour across all measures. For example, the high toleration of delays by P727 could have occurred due to repetitive patterns of behaviour presented by P727 as a core symptom of his diagnosis of ASD. Data obtained for P411 on the SCTs and PDT measures showed slight discounting at baseline and complete delay tolerance throughout the remaining measures. It seems possible that such choice responding could have been affected by response bias (in predicting the researcher's expectation) and experiencing anxiety at initial baseline due to lacking control over the situation followed by the feeling of extreme control in the remaining measures (a characteristic of Pathological Demand Avoidance syndrome).

On the other hand, data obtained from adolescents with BESD in the present study were varied, especially for those with diagnoses of ADHD and reported challenging behaviour, including P2117, P1415 and P622. Behaviour observations (COC) suggest that week 6 was possibly a poor week for P727, as mentioned previously, due to the increased presentation of impulsive behaviour in a number of measures. However, week 16 was likely to have been a good

week for P727 as measures show no holds, generally below 20 percent target behaviour (COC) and almost 100 percent attendance. It could be maintained therefore that data obtained and the somewhat inconsistent session attendance for P2117 and P622 in particular offers a valid representation of behaviour presented by such individuals.

Attendance was highly variable and appeared to increase throughout the intervention, though it seems possible that such an increase involved school related factors as attendance increased prior to Experiment 7. Observations using the COC were conducted solely by the principal researcher, and therefore a limitation of the present study was that no inter-observer reliability measure was available. However, consistency between observations was high as the researcher was experienced at administering the COC and there was evidence that observations were valid, in that there were consistencies between the COC and results obtained from other measures, some of which were not recorded by the principal researcher (including staff ratings, attendance and safety hold data).

Classroom observation data suggest no effect of the pre-intervention control for most participants, with the exception of a slight increase in undesirable behaviour for P622 and P411. It is possible that the regular one-to-one attention in sessions may have influenced behaviour of these participants in the initial phases of the study. P411's attendance decreased during post-intervention, possibly in an attempt to gain attention having finished the one-to-one sessions, which he appeared to enjoy.

Participants P1417, P727 and P411, who completed all phases of the 16 week multiple-baseline programme, presented decreased behaviour in the classroom observations somewhat more consistently than those participants who did not complete the programme. P622 presented slightly decreased undesirable behaviour during the intervention, but his behaviours gradually returned post-intervention possibly due to inconsistent and limited attendance to mindfulness sessions. Similarly, P2117's behaviour decreased then returned to slightly below initial observations towards final observation weeks. P2117's attendance slightly increased during the intervention, but decreased post-intervention possibly due to external factors at school, or less engagement with, or not completing, mindfulness exercises.

Furthermore, participants 1417, 727 and 411 presented less varied choice responding and tolerated larger delays in the SCTs and PDT than P622, P2117 and P1415 who did not complete the 7 weeks of mindfulness training. Safety holds for P1417, P727 and P411 were less than those recorded for P2117 and P1415 throughout the entire program. Therefore, consistent attendance to training may identify individuals who are generally less impulsive, made more improvements on measures, especially in the behaviour observations, and further improvements were seen from post-intervention to follow-up measures. It should be noted, however, that P411 presented least undesirable behaviour throughout the 24 weeks of observation and reported to have practiced meditation at home independently prior to the 16 week programme, as he had been taught it whilst at a previous school and had seen it on a children's television program.

In response to an issue raised by Bögels et al. (2008) regarding drop-out rates of participants in group sessions, sessions in the present study were conducted individually to reduce the effect of peer influences on session attendance. It is noteworthy that, in discussing the training during a final mindfulness session, P622 mentioned to the experimenter that he had not discussed the mindfulness-based training with anyone as he found it too embarrassing. On the other hand, P411 spoke to his mother about the sessions, who reportedly said such training would be highly beneficial for him. This particular participant enjoyed the mindfulness training and was keen to continue sessions so was encouraged to continue his practice at home on completion of the study.

In light of the non-compliance and distraction issues reported by Bögels et al., and concerns such as feeling humiliated discussing mindfulness with friends and family, it appears important to commence mindfulness training in one-to-one sessions rather than in groups for adolescents with BESD. This supports the suggestion made by Bögels et al. that children with externalising disorders, especially those with ODD and CD, might benefit from beginning mindfulness training in individual sessions to reduce distraction.

Unlike Bögels et al. (2008) in which homework was set, but only completed by a minority of participants, participants in the present study were given no direct homework. Instead they were asked and advised to practise the mindfulness exercises learnt in the intervention sessions in their own time. However, as in Bögels et al.'s study, participants generally reported that they had not practised, with the exception of P411, though mindfulness of music was reportedly practised by P1417, P2117 and P1415. Future research might involve

conferring with parents/carers/key workers/teachers to encourage practice out of sessions. Nonetheless, it seems important that mindful practice is not forced, as it is likely that such pressure might result in individuals refusing to attend sessions. After initial individual training, group mindfulness sessions in school run by the class teacher might produce beneficial results due to the strong peer influence to the promotion of non-judgemental awareness in mindfulness. For adolescents with BESD it would be beneficial to gradually increase the number of individuals within a group, as individuals become more familiar with mindfulness practice and can successfully participate in group sessions.

In support of findings reported by Bögels et al., mindfulness sessions seemed to improve and relax participants. However, it is likely that further improvements in behaviour might have resulted from further mindfulness training, although it remains vital to consider the length of sessions and session content to maximise potentially beneficial effects. The principal experimenter noted that participants frequently brought with them challenging issues that they had either dealt with or issues of concern. It is likely that application of exercises that focus on issues, such as bullying or feelings of a sexual nature, could provide beneficial techniques for children and adolescents to deal with such issues more independently. As mentioned by Bögels et al., future research should employ mindfulness training to larger samples over longer durations. Once children and adolescents with a range of BESD are successful at basic mindfulness practices future research can be applied to more specific issues that children and adolescents are experiencing at the time of the sessions. However, given the possible sensitive nature of difficult issues that may be

raised, it is important that the therapist is experienced in dealing with such issues within mindfulness practice.

It is interesting to discover the variability and inconsistencies between commonly recognised measures of impulsivity and self-control within individuals. It seems reasonable to question the validity and usefulness of the application of such measures for individual diagnostic use as they only work in the average over large samples. However, the PDT might be more useful as a simpler and more flexible alternative to the delay discounting measures of the CCT and SCT.

Experiment 7 data appeared to suggest increased self-reported mindfulness in P727 who held a primary diagnosis of ASD. Further research is necessary to determine whether self-awareness skills can be developed through training such as mindfulness-based practice. Such research could increase insight into possible behavioural and cognitive components of impulsivity, self-control and self-awareness and explore interventions such as mindfulness-based therapy for use with this population and others. Results obtained from this study support the work of Bögels et al. in providing evidence to suggest the potentially beneficial effects of mindfulness training in adolescents with a range of behavioural, emotional and social difficulties, including those with externalising disorders, such as ADHD, ODD, CD and ASD. Further research into the effectiveness of interventions such as mindfulness that improve self-control and self-regulation in children and adolescents with a range of Behavioural, Emotional and Social Difficulties would be highly valuable to such individuals.



## **Chapter 7**

### **General Discussion**

#### **7.1 Main Goals**

The present research project was designed to explore the relationship between thinking and impulsive behaviour in adolescents with behavioural, emotional and social difficulties (BESD). Mindfulness is a form of focussed thought that appears trainable in a wide range of populations, and provides the basis of several therapeutic interventions, such as Acceptance and Commitment Therapy (ACT).

The relation between impulsivity and mindfulness had not previously been investigated directly. However, it appeared reasonable to propose that such a relationship might exist. A primary aim of the current project therefore, was to examine whether the measures of impulsivity and of mindfulness were indeed related. If results provided evidence to suggest that high impulsivity was correlated with low mindfulness, the final aim was to determine whether methods designed to develop mindfulness would reduce impulsive behaviour in adolescents with behavioural, emotional and social difficulties (BESD). If employing a mindfulness-based therapeutic intervention induced more mindful awareness and so reduced impulsive responding, it might facilitate the development of more effective behavioural self-regulation and improve future prospects of adolescents with BESD.

Given the collaborative nature of the present project with an education provider to facilitate more effective self-regulation in adolescents with BESD, it was



necessary to explore measures, relationships between measures and the effectiveness of mindfulness-based therapy in the mixed sample of adolescents with BESD at the participating school. It was therefore not possible to control for specific diagnoses, particular behavioural characteristics, medication, age or background for example, and as a result, was likely to generate large variance across measures. Issues associated with working such a mixed sample will be discussed at relevant points throughout the current chapter.

## **7.2 Review of studies conducted in the present thesis**

Pilot studies were carried out to determine whether a novel delay discounting task, the computerised choice task (CCT), effectively measured impulsive choice, and whether it was suitable for use with adolescents with BESD.

Several participants in Experiment 1 reached corner solutions, suggesting that either the CCT was itself reinforcing, the monetary reward was too highly valued, or the delay was not large enough to produce discounting behaviour. Several distracting graphics were subsequently removed and the delay to the LL reward was increased for Experiment 2. These changes did result in slightly higher rates of discounting, but indicated the need to increase delays further in future studies.

In contrast to initial predictions, response time (RT) data from Experiments 1 and 2 showed participants took more time on average to make impulsive choices (choosing the more immediate (SS) reward option) than self-controlled choices. However, problems with the adjusting procedure made it possible that the RT data lacked validity, so additional RT data were required to determine

whether smaller RTs were correlated with impulsive choices, and whether larger RTs were correlated with more self-controlled choices.

Initial calculation of IP in Experiment 1 was found to be not reflective of some of the adolescents' responding (e.g., P1 received an IP of 7.4, although he only chose SS when it was equal to the 10p LL reward amount and had rejected all 8p SS rewards). As a result, the calculation of IP for adolescents who chose all LL or SS only when it was equal to the 10p LL reward amount was altered to reflect responding more precisely in Experiment 2. Although the CCT and adjustment procedure required modification, results from Experiments 1 and 2 suggested that the CCT was a suitable task for measuring delay discounting in adolescents with BESD.

Many participants in Experiments 1 and 2 reached their IP and produced consistent patterns of responding on or before six of the total 20 choice trials. Several of these individuals increased their rate of discounting in the final trials, possibly suggesting some form of satiation or aversion to the session duration. Consequently, a more direct procedure (the Decreasing Adjustment Algorithm: DAA) developed by Du et al. (2002) was considered more suitable and was adopted in Experiment 3.

Six choice trials were presented at four delays of 15, 30, 60 and 65 seconds in Experiment 3, instead of the 20 choice trials at one delay. Due to the adjustments and reward amounts used in the current project, SS values were often presented as decimal numbers. As it was anticipated that the adolescents with BESD might have difficulties understanding fractional values, Experiment 3

involved further modification of the CCT by rounding values to whole numbers. This modified version (DAA (R)) was compared to the original Du et al. (2002) version (the DAA) in University students and RT data were recorded. In addition, the Junior I.6 (Eysenck et al., 1984) and the Child Acceptance and Mindfulness Measure (CAMM: Greco & Baer, 2005) were administered to explore relations between measures of impulsivity and mindfulness.

An ANOVA carried out on the data from Experiment 3 revealed a significant main effect of delay in the direction typical of discounting tasks, with the students discounting more steeply as the delay increased. There was no effect of version suggesting that both versions produced similar results and there was no effect of version order on IP or RT. In contrast to Experiments 1 and 2, mean RTs were slightly (but not significantly) smaller when participants chose the SS reward and larger when they made more self-controlled choices in Experiment 3. Seventy percent of participants produced typical discounting (discounting the LL more rapidly as the delay to it increased), suggesting that the task, delays and monetary rewards used were sufficient in assessing most participants' discounting. Mean IP and mean RT were closely related within each CCT version, with mean IP and RT in the DAA significantly correlated. This supports our initial theory that more impulsive students respond more quickly to choice options. However, no significant correlations were found between the CCT and either self-report scale, or between the Junior I.6 and the CAMM.

To obtain a more accurate indication of discounting behaviour produced using the DAA (R), university students were presented with the DAA (R) version of the CCT only, the Junior I.6 and the CAMM in Experiment 4. Due to a problem with

the CCT (presenting the intended 90 second delay as 65 seconds), it was reprogrammed after the first ten participants and administered to a further 30 undergraduates with correctly intended delays of 15, 30, 60 and 90 seconds.

Rates of discounting varied in Experiment 4, however the majority of students produced increased rates of discounting as the delay to the LL reward increased, resulting in a significant main effect of delay on IP. There was a trivial difference between RTSS (response times for SS choices) and RTLL (response times for LL choices). Mean IP and RT in combined results were significantly correlated suggesting faster responding was produced by students who responded more impulsively. Although results for parts I and II showed no significant correlation between the Junior I.6 and the CAMM, combined results revealed this relationship to be significant, providing preliminary evidence to suggest a negative relationship between self-reported mindfulness and impulsivity. Results revealed no other significant correlations between IP, RT and the Junior I.6 or the CAMM.

As the CCT and two self-reports were intended to measure impulsivity and mindfulness in adolescents with BESD, Experiment 5 involved the administration of these three measures to 28 adolescents with BESD. In addition, staff impulsivity ratings (SIR) and behaviour observations (using the Classroom Observation Code, COC: Abikoff & Gittelman, 1985) were obtained. Four of the first five participants tolerated all delays so delays were increased to 30, 60, 90 and 120 seconds for the remaining 23 participants. Although discounting rates varied between participants, average IPs showed the expected delay effect, with a slight decrease in IP as the delay to the larger

reward increased. However, the effect of delay on IP in Experiment 5 was not significant.

Average (mean) RTs in Experiment 5 were slightly (but not significantly) larger when participants made impulsive choices (SS rewards), supporting the results from Experiments 1 and 2. Observations of individual RT data did not appear to show an increase in RT as the boys reached their IP (towards the end of each series of choice trials). The boys who made impulsive choices at one delay made similar impulsive choices at other delays, those who responded more quickly at one delay responded quickly at other delays and there were some significant correlations between composite behaviours obtained from the COC.

Nonetheless, there were no significant correlations between IP and RT data or between IP, RT and either self-report measure or the COC in Experiment 5. The SIR was not significantly correlated with IP, RT or the CAMM, but SIR obtained from the second member of staff was significantly correlated with the Junior I.6, suggesting that boys who had reported themselves to be more impulsive, were rated as more impulsive according to this member of staff. In support of findings from Experiment 4, there was evidence to suggest that adolescents scoring high impulsivity (Junior I.6) scored low mindfulness (CAMM) in Experiment 5. Given the higher tolerance of delays by adolescents with BESD than university students, it was questioned whether the adolescents were prolonging session duration to extend time out of class, or whether the CCT possessed reinforcing characteristics itself.

In an attempt to answer this question, Experiment 6 was designed to explore the effect of task type (computer and sand-timer) and context (school and house) on participants' choice responding. An ANOVA revealed a significant effect of delay on IP (in the anticipated direction, where mean IP decreased as delay increased), a two-way interaction between task type and context, and an interaction between task type, context and condition order. There was a moderate, but not significant effect of task type on IP with adolescents producing most self-controlled responding when using the computer task in the house, and most impulsive responding when using the sand-timer in the house. There was a significant negative correlation between average self-reported impulsivity (Junior I.6) and mindfulness (CAMM) scores. Pupils presenting high levels of impulsive and other undesirable behaviour in the classroom (COC) had higher staff rated impulsivity, lower BSCS scores and chose more impulsively in three of the choice tasks. Five month test-retest reliability was identified for the Junior I.6 suggesting it was suitable for repeated use, but not for the CAMM.

As results from Experiment 4, Experiment 5 and Experiment 6 provided preliminary evidence to suggest a relation between impulsivity and mindfulness, a mindfulness-based skills training intervention was administered in Experiment 7 to determine its effect on the behaviour of six adolescents with BESD. Although the sand-timer choice task in school (SCTs) was used to measure discounting, participants initially presented high toleration of delays (30s and 120s) so a further 180s delay was added and a PDT (Progressive Delay Task) was designed to determine how long participants were willing to wait for a monetary reward. Although generally unrelated to other measures, the SCTs and PDT produced similar results. The self-report scales were also generally

unrelated to other measures. Classroom observations and staff ratings of pupil's general impulsivity generally decreased across the intervention phase, providing preliminary evidence that mindfulness-based training could benefit adolescents with BESD by reducing undesired, impulsive behaviour.

### **7.3 Interpretations of the main findings, limitations, and future research directions**

#### **7.3.1 The delay discounting task**

Several modifications of the choice task were required to develop a suitable and effective measure of delay discounting for adolescents with BESD. Results from Experiments 1 and 2 showed that several of the adolescents with BESD exhibited a high toleration of delays, with most boys reaching their IP and producing consistent patterns of responding on or before choice trial number 6. However, as there were a total of 20 choice trials, some adolescents produced increased discounting towards the end of the task, suggesting possible aversion to the overall session duration.

The discounting procedure designed by Du et al. (2002) seemed more suitable as it required only six choice trials to be presented to obtain an indifference point at a single delay. However, as mentioned in chapter 1, a concern was that each indifference point (IP) would be largely determined by a participant's initial choices, and that participants would be forced towards a point of indifference (IP). Nonetheless, the presence of a practice task enabled participants to become familiar with the adjustments and the task, reducing the possibility that individuals would be forced into their IP.

The adjustment procedure modified from the DAA developed by Du et al. (2002), was successful in converging on indifference points (IP) at a range of delays. As only six choice trials were required to obtain a single IP, discounting at several delays could be tested. Using only six choice trials at four delays reduced the effect of presenting many choice options at a single delay as individuals became bored and consequently choose more impulsively in the final choice trials. Therefore, it could be suggested that the DAA (R) choice task was more suitable as a measure of delay discounting in adolescents with BESD than the initial 20 choice trial task used in Experiments 1 and 2.

In support of initial expectations and of findings by Ainslie (1975) and Neef et al. (1993), participants varied substantially in the rate at which they discounted the larger later (most profitable) reward. Delay to the larger later (LL) reward was increased in several experiments throughout the project as it became increasingly difficult to bracket participants' discounting (i.e., selecting delays that were sufficiently short for participants who discounted steeply and sufficiently long for participants who were highly delay tolerant). Although discounting rates were highly varied, results suggested that on average, the discounting tasks were valid as they produced discounting typical of such tasks (as shown in several of the ANOVAs, planned comparisons, and individual indifference curves) whereby participants discounted the delayed reward more as the delay to it increased.

Given the mixed intake of pupils with BESD at the collaborating school, the range of diagnoses, individual characteristics, backgrounds and medication was likely to produce mixed results, such as the large variation between individuals'



rates of delay discounting. It is likely therefore, that the small sample size and heterogeneity of the sample resulted in underpowered statistical analyses. Nonetheless, it was necessary to assess discounting across adolescents as tailoring delays to suit individuals would have been extremely time consuming. It was also possible that such variations in individualised delays could result in very large differences between individuals' session durations, confounding the discounting data obtained. Therefore, it was desirable to bracket all participants' responding with a series of fixed delays in the delay discounting task.

Having re-tested the choice task with various delays in attempt to bracket participants' discounting, it was believed that delays used in Experiment 6 would be suitable to present to participants in Experiment 7. However, the six participants in Experiment 7 produced highly tolerant, low rates of discounting initially, so in subsequent trials, delays were increased further. Again there were large variations between participants' discounting, ranging from one participant who continually tolerated the largest delay, to participants who discounted the smallest delay. Given the large variation in delay tolerance of participants, it was difficult to bracket delays using the SCT. Consequently, an additional measure was designed for use in Experiment 7 to determine the duration participants were willing to wait in order to receive a larger reward.

The PDT was developed from an adaptation of a self-control task (Beran & Evans, 2009) and a delay maintenance task (Toner, Lewis & Gribble, 1979; Toner & Smith, 1977). Although it could be maintained that the PDT, CCT and SCT each required participants to choose between larger delayed rewards and smaller more immediate rewards, the presentation of choice options differed.

The CCT and SCT measured delay discounting by presenting a series of choices between smaller more immediate rewards and larger more delayed rewards. Whereas, the PDT measured delay of gratification by offering participants the choice of whether to wait and accumulate small monetary rewards across progressively increased delays, or choose to receive a small monetary reward immediately.

Discounting tasks have been thoroughly researched, and appear to be the conventional method of measuring and predicting impulsive choice in a range of populations (see chapter 1). On the other hand, delay maintenance tasks like the PDT have received considerably less attention. According to Toner, Holstein and Hetherington (1977), delay discounting and delay maintenance behaviours are independent in children. However, in the present research it appeared that the SCT and PDT both measured impulsive choice, as results for each participant in Experiment 7 were similar across tasks.

Delay discounting tasks produce indifference points, from which discount curves can be plotted. As mentioned in chapter 1, discount functions can be applied to determine the fit of discount curves to the hyperbolic curve, and used to predict delay discounting. However, in the current thesis and for many research purposes, what was required was a single measure of behavioural impulsivity. As the delay to the larger reward is pre-defined and fixed in the CCT and SCT, a measure of choice responding would not be possible with a participant who is highly self-controlled and tolerant of the delays selected. Although the PDT does not produce a discount curve, it guarantees a choice of SS eventually, when the other tasks do not. Since the PDT is more sensitive than the CCT and

SCT to the large differences between the length of delay participants are willing to wait to receive a large reward, the PDT yields a measure of behavioural impulsivity more efficiently and flexibly than the CCT or SCT. In response to the difficulties met in successfully bracketing the highly varied rates of delay discounting, it is reasonable to propose that the PDT should be given serious consideration as a more suitable measure of impulsive choice in adolescents with BESD, rather than the more commonly used delay discounting tasks, such as the SCT and CCT.

In response to the highly varied response patterns and bracketing problems encountered with the CCT and SCT, the PDT appeared to be a valuable way of determining how long a delay would be tolerated in populations such as those in this research. The PDT could be used as an initial task to gauge delay tolerance or reward value (Lagorio & Hackenberg, 2010), with the view to setting parameters more effectively in future discounting tasks (from which discount curves can be produced). It may be that discounting tasks such as the SCT might be more suitable for studying delay discounting in other populations, such as typically developing children, due to its simplicity. However, it could be argued that studies presenting several choice trials that require participants to respond consistently generate more valid indifference points than in Du et al.

Initial concerns that the adolescents would be difficult to motivate and recruit were found to be misplaced, as participants presented unexpectedly high toleration of delays, even when the task was repeatedly administered. The majority of adolescents who participated in Experiments 1, 2, 5, 6 and 7 were diagnosed with disorders on the Autistic Spectrum (ASD) and Attention Deficit

Hyperactivity Disorder (ADHD), both of which the DSM-IV-TR (2000) identifies as including characteristics of inattention, hyperactivity and impulsivity. Consequently, it was expected that the adolescents would produce higher rates of discounting than university students. However this was not the case, as the adolescents with BESD were more tolerant of the delays and produced more self-controlled responding on average than the university students.

Although previous research has revealed similarities between using real and hypothetical rewards in delay discounting research (e.g., Johnson & Bickel, 2002, and Johnson et al., 2007) it was considered important to use real rewards in the current work to facilitate participants' understanding due to learning difficulties and the assumption of poor understanding of simulated situations in some adolescents with BESD. Real monetary rewards were used in the existing token economy at the school and so were familiar to the participants. In addition, given the likely differences in reward preferences between participants, money functioned as a generalised (conditioned) reinforcer (see section 1.6) exchangeable for desired primary and secondary reinforcers (Estle et al., 2007). Furthermore, in response to Hoerger and Mace (2006) who emphasised the importance of using relevant and functional tasks and rewards in discounting studies, monetary rewards were considered relevant and functional to both adolescents and university students.

One issue not explored in the current thesis due to time constraints was the effect of the reward on participants' tolerance of delays. The CCT, SCT and PDT used real money as the reward in order to maintain consistency with the school's token economy with which the adolescents were familiar, and facilitate

understanding by using a tangible reward. To further ensure understanding, rewards were visible to the participants to represent the amounts of money on offer by placing money chosen into a transparent container. It is possible that such visual presentation of reward accumulation enhanced the perceived value of the money, reducing the frequency of discounting. However, due to time constraints it was not possible to manipulate the reward amounts in addition to increasing delay to reward availability in the current project, therefore only the latter was explored.

Reward directed attention has been found to be detrimental to a child's ability to wait for a delayed reward (Mischel & Ebbesen, 1970; Toner, Lewis & Gribble, 1979). However, studies in the present project showed that adolescents with BESD presented surprisingly high toleration of delays even when the reward was clearly visible. In light of such research outcomes, one might predict that when presented with rewards disguised and referred to as 'tokens', adolescents with BESD are likely to increase their toleration of delays further.

It is possible that previous monetary experience affected the immediate value university students and adolescents placed on rewards (as suggested by Kirby et al., 2002). For example, university students were likely to have experienced earning larger amounts of money through paid employment and therefore valued the 10p reward as relatively small, and so were more likely to produce higher rates of discounting; whereas the adolescents had experienced earning small amounts of money (e.g., through the schools token system), and therefore valued the 10p reward as relatively high and were less likely to discount it.

However, Kirby et al. (2002) also reported that discount rates decreased with recent income increases, suggesting that the monetary reward participants received in each choice task affected their responding in future tasks. This possibly explains the stable rates of discounting or the decrease in discounting produced by several participants.

Only one delayed reward amount and only one type of reward was used in the seven experiments carried out. Due to situational effects and previous history of earning monetary rewards, there were likely to be large differences between the value placed on rewards by the mixed sample of participants. Furthermore, motivation to receive the monetary reward in the CCT, SCT and PDT was highly situation dependent (e.g., P1417's motivation in Experiment 7 was affected by his aim of saving for an Xbox). Although we could have asked participants to choose their reward, given the accumulation of small rewards in the CT and the requirement for rewards to be real, rewards would have been limited to options such as consumables (e.g., sweets or chocolate) or money. As money was a generalised conditioned reinforcer (i.e., it could be accumulated and exchanged for desired items and activities later), it was considered that this was the most easily utilised and appropriate form of reward for adolescents with BESD.

Reward value is also determined by motivation for that reward at the time of presentation, and this is difficult to control. For example, if an organism has eaten a large quantity of food he or she is less likely to act to obtain a food reward, and we may presume the subsequent present value of the food reward has decreased. On the other hand, if an organism has not eaten for a prolonged period of time, it is more likely that he or she will act to obtain a food reward,

and we may assume a greater present value of the food reward. In the present research, it is certain that these factors influenced choice. For example, P1417 in Experiment 7 explained to the experimenter that he was saving for an Xbox and therefore had increased motivation to tolerate the delays. On the commencing testing session P1417 produced higher rates of discounting as he had less motivation to save, having bought the Xbox. Consequently, this participant's impulsivity was largely influenced by environmental factors rather than his predisposition to choose either impulsively or make more self-controlled choices in the SCT and PDT.

One explanation for untypical and unsystematically varying discounting response patterns is provided by Dholakia, Gopinath and Bagozzi (2005) who suggested that an individual's impulsive responding in one task would reduce the likelihood that the same individual will choose impulsively in a following task (the sequential mitigation effect). Furthermore, as highlighted by Rachlin (1995), different discounting rates are likely to exist between individuals due to individual differences in learning and previous reinforcement experience.

In accordance with Solanto et al. (2001), participants were told how many choice trials they would receive. Therefore, participants may have chosen the LL reward more in the final trials at each delay to maximise their reward before the end of each condition or overall session. It seems possible that informing participants of the number of choice trials they would receive might have reduced ecological validity of the CCT and SCT. Although participants were not told how long the delay to the LL reward was going to be, it could be argued that changing the sand-timer between delays provided a cue for the

adolescents to expect a larger delay given the increased volume of sand from one sand timer to the next. On the other hand, the CCT did not provide any such visual cue. As maintained in section 5.4 however, it appeared that although participants in the current project were unaware of specific delay durations, they expected a systematic increase in delays in the CCT as suggested by their responding and comments made during the choice tasks.

One could question the ecological validity of such knowledge. For example, an individual trying to quit smoking would not know how long it would take to be rewarded with the health and wealth benefits of not smoking, and similarly unlikely to know how many times he or she would encounter this choice. An individual attending a weekly weight loss program might be rewarded weekly by observing small weight decreases, however he or she is likely to be unaware of the point at which he or she will be rewarded when his or her target weight is reached or the number of choices he or she would experience along the way. It could be argued that such knowledge was ecologically valid within the present project as pupils might have some idea of the duration to wait until their act of self-control will pay off (e.g., when they can spend the money earned from having a good week at school).

It is important to consider such issues in relation to past and future choice research. Research presenting participants with hypothetical reward amounts available after specified delays (e.g., Simpson & Vuchinich, 2000; Mitchell, 1999; Du, Green & Myerson, 2002; Johnson & Bickel, 2002) appear relevant to financial decision making, but are less relevant to an individual trying to reach a specified target weight. Future research should be transparent about such



knowledge depending on the relevant behaviours of the population being studied.

Two further explanations for the lower rates of discounting in adolescents concerned the delay discounting task and the context in which testing was carried out. It appeared possible that adolescents were either choosing to wait for the delayed reward to prolong time out of class, or as a result of the task having been presented in the form of a simple computer game. These questions were tested in Experiment 6, and results showed that the adolescents generally made more self-controlled choices when they received the computer game-type task. There was no significant main effect of context on IP, however, there was a significant interaction between context and task type. This therefore suggested that participants discounted less steeply when the choice task was a simple computer-game, rather than choosing to wait to prolong time out of class. As the CCT was found to produce an increase in self-controlled responding, the SCT was adopted as the preferred measure of delay discounting for the final study.

Computer and video games were popular activities enjoyed by most of the adolescents. In support of previous research (e.g., Malone, 1981; Donchin, 1995; Antonietti & Mellone, 2003), results from Experiment 6 emphasise the increased attention and self-controlled responding adolescents with inattention, impulsivity and hyperactivity can present when given a simple computer game-type task.

Finding that the outcome of the delay discounting tasks was affected by the method of task delivery (computer versus sand timers), in addition to finding that task type made little difference in school, but a large difference between tasks in the residential setting, raises several issues. If impulsive responding is so context dependent and one can change whether an organism responds impulsively on choice tasks by changing the task location or task method (or other parameters for that matter), can we have confidence in the literature based on such methods? Such large interactions between task type and context emphasises the need to consider the methods with which choice tasks are delivered, and context of testing. Considering the effect of task type and context is therefore important in future research to obtain generalisable and valid measures of discounting. However, as the computer game type task was found to facilitate self-controlled responding, future research might address the benefits of such tasks to training and educating individuals such as adolescents with BESD.

According to Griffiths (2002), although much research has presented a negative account regards the consequences of video and computer game playing, there are some clear advantages concerning the development of skills such as problem-solving. Griffiths highlights the potentially beneficial effects of computer and video games specifically designed for education and development purposes. Barriers encountered by teachers and other professionals in educating and promoting the development of children and adolescents might be eased by such computer games, particularly with adolescents such as those with BESD.

As mentioned in section 5.1, such methods have been used to facilitate skills in adolescents with special needs including Autism (e.g., Gaylord-Ross, Haring, Breen & Pitts-Conway, 1984; Sedlak, Doyle & Schloss, 1982; Demarest, 2000). Although the game in the present project was designed to measure impulsivity rather than to train, participants were most self-controlled in the computer task, emphasising the beneficial effect of the computer game on participants' behaviour. Further research into the potential of computer games for purposes of development and education is required, in addition to exploring how playing computer games, sustained attention and self-control are related.

Although slightly less accurate than the computer in presenting delays, sand-timers (Sand-timer choice task: SCT) removed the unsocial and highly familiar computer aspect of the task, and added a component of social interaction between participant and experimenter whereby the participant was required to say what their desired choice was. It was likely that this aspect of social interaction would be aversive for some of the adolescents (in particular those with ASD due to related impairments in social interaction and communication as specified in the DSM-IV-TR, 2000), and higher discounting rates to escape the situation were expected. Although participants appeared unaffected by the additional interaction component in the SCT, relationships between diagnosis and rates of discounting in Experiments 6 and 7 were inconclusive however, as diagnoses, medication and rates of discounting differed so greatly between participants, it was not possible to draw conclusions on the effects of the sand timer on individual participant's responding. This is discussed further in section 7.3.3.

Several explanations for impulsive behaviour have been suggested, including deficits in regulatory functioning and inhibitory processes (Sonuga-Barke, Taylor, Sembi & Smith, 1992). However, Sonuga-Barke et al. proposed three possible economic functions for choosing a more immediate option: true impulsiveness, reward maximisation and delay aversion. Specifically, true impulsiveness involves the maximisation of reward immediacy and minimisation of pre-reward delay; delay aversion involves the minimisation of overall delay; and reward maximization involves maximising the quantity of rewards obtained in a testing session.

Sonuga-Barke et al. suggested that hyperactive participants were not sensitive to pre-reward delay (and hence not impulsive) as they chose LL rewards (worth 2 points, with a pre-reward delay of 30 seconds and a post-reward delay of 2 seconds) more frequently than SS rewards (worth 1 point, with a pre-reward delay of 2 seconds and post-reward delay of 30 seconds). This was the most profitable responding participants could have produced. But interestingly, hyperactive children chose more LL rewards (with an average of 75 percent) than control children (who chose the LL reward on average 55 percent of the time). After removing the post-reward delay and constraining the number of choice trials to 20 however, hyperactive participants chose the LL reward less than the SS reward suggesting that participants wanted to complete the task more quickly, rather than earning the maximum amount of money within the 20 trials.

Sonuga-Barke et al. (1992) argued therefore that hyperactive participants were not impulsive, but rather more delay averse than controls. However, as

suggested by Sonuga-Barke et al., it was possible that participants did not fully understand the trials constraint condition as they had been presented with similar tasks involving slightly different features previously. In addition, it is possible that the reward was not motivating enough, or less valuable than the alternative option of reducing the overall session duration; whereas there was no option to reduce the session duration in the post-reward delay condition. From a behavioural perspective, as only two small rewards were used, it seems likely that the motivation to escape the situation might have been greater than the motivation to earn the reward in the trials constraint condition.

Since the CCT and SCT involved only pre-reward delays and a set number of choice trials, one could question whether they measured true impulsivity or delay aversion. As the number of choice trials presented at each delay was set, the discounting tasks in the present project controlled for reward maximisation; it was not possible for participants to maximise profit by choosing the SS reward option more frequently throughout the session. The initial CCT that involved 20 choice trials and one LL delay throughout was similar to the trials constraint condition in Sonuga-Barke et al. (1992). However, 20 trials appeared to be more than necessary for several participants, as consistent patterns of responding were produced rapidly and IPs were reached within six trials. In addition, several participants presented increased rates of discounting in the final trials suggesting some degree of delay aversion towards the end of the session. To tackle this issue, the CCT was modified to present six choice trials at four delays; a procedure adapted from Du et al. (2002).

In the DAA (R) version of the CCT and the SCT, to obtain the largest profit within the shortest time possible it was necessary for participants to choose the 10p LL reward on four occasions then choose the 10p SS reward in the final two options in each delay condition. Such responding would produce a large IP and was indicative of highly self-controlled responding. Adolescents with BEDS produced highly varied responding in the present research. In contrast to the delay aversion hypothesis by Sonuga-Barke et al. (1992), some adolescents produced highly self-controlled responding despite the option to maximise reward immediacy and minimise the session duration by frequently choosing SS rewards. It is possible that this was because larger monetary rewards were offered in experiments in the present project compared to the small rewards offered by Sonuga-Barke et al. (1992). Therefore, it could be argued that in the present research adolescents with BEDS were generally not delay averse, as they did not choose SS rewards all of the time. In fact, due to the high tolerance of delays by several participants, it was necessary to increase delays so that discounting would be produced and a measure of impulsive choice be obtained. It therefore seems reasonable to argue that the delay discounting tasks designed in the present thesis measured impulsive choice rather than delay aversion.

Furthermore, the response times (RTs) suggested that individuals did not make choices rapidly to reduce the overall session duration (argued by Sonuga-Barke et al., 1992, as representing delay aversion), as RTs did not generally decrease as the number of choice tasks increased. Evidence from the current project therefore implies that the delay discounting task designed for use in the present thesis effectively measured impulsive choice in adolescents with BEDS by

adjusting the SS reward according to participants choice responding, and subsequently obtaining points at which individuals discounted the LL reward across a series of increased delays.

It appears that the degree to which one's behaviour is impulsive is highly dependent on the specific features of the impulsivity measure. This is emphasised by the differences in behaviour produced by the slight alteration of contingencies in Sonuga-Barke et al.'s (1992) study. The consideration of such issues is crucial when reviewing and selecting tasks to measure impulsivity.

### **7.3.2 Correlations between measures of impulsivity**

The validity of discounting tasks has been investigated through exploring correlations between novel delay discounting tasks and frequently used measures such as self-report scales (e.g., the Eysenck I.6). Correlations between discounting and self-report measures have been reported by Kirby, Petry and Bickel (1999); Mitchell (1999); Madden et al. (1997); Mobini et al. (2007); Duckworth and Seligman (2005); Beck and Triplett (2009); Crean, De Wit and Richards (2000). Additionally, Hoerger and Mace (2006) and Solanto et al. (2001) found correlations between discounting tasks and behaviour observations and teacher ratings of impulsivity. However, as mentioned in chapter 1 of the current thesis, research has produced mixed results with several studies reporting no evidence of correlations between discounting and self-report measures including Coffey, Gudleski, Saladin and Brady (2003); Vuchinich and Simpson (1998); Reynolds, Ortengren, Richards and De Wit (2006); Fields, Collins, Levaas and Reynolds (2009).

Within the current project, to validate the CCT as a measure of delay discounting several additional measures of impulsivity were administered and results were compared. Correlations between the CCT and SCT, self-reports, staff impulsivity ratings and behavioural observations were limited and inconsistent across studies. Most correlations were identified in Experiment 6 in which undesirable behaviour in the classroom correlated negatively with indifference points obtained on the CCT and SCT, and correlated positively with several staff ratings. Experiment 7 also identified several correlations between measures, however due to the individual case analysis and small number of participants, results are difficult to generalise. Furthermore, as mentioned previously, it is possible that the limited correlations were due to the low power of the statistical analyses as a result of the heterogeneous and small sample. Nonetheless, correlations were evident within self-reported impulsivity measures (a finding similarly reported by Fields et al., 2009; Reynolds et al., 2006; Miller, Joseph & Tudway, 2004). Results from Experiment 7 also found the SCT to be positively correlated with the PDT, suggesting these measures assessed similar constructs.

Inconsistencies between methods that claim to measure impulsive behaviour may suggest that they assess different aspects of impulsive behaviour. For example, the results reported in Experiment 3 (section 3.4), Experiment 4 (section 3.8), Experiment 5 (section 4.3), Experiment 6 (section 5.3) and Experiment 7 (section 6.3) suggest limited significant correlations between self-report impulsivity measures and delay discounting tasks. Reynolds et al. (2006) suggest that the lack of correlation between impulsivity measures indicates the existence of different impulsivity constructs. However as emphasised by Bickel



and Marsch (2001), further research into the relations between measures of impulsivity is required. Furthermore, there is insufficient data on the relationship between measures of impulsivity and impulsive behaviour produced in natural environments such as in classrooms, at home and in financial decisions (Hoerger & Mace, 2006; Solanto et al., 2001).

Identifying a suitable measure of impulsivity requires consideration of the population being studied (Kowal, Yi, Erisman & Bickel, 2007). Classroom observations are high in ecological validity, but are affected by situational factors that are difficult to measure and control. Delay discounting (CCT and SCT) and delay maintenance (PDT) tasks measure impulsive choice directly through presenting participants with conflicting stimuli which evoke a response that is reinforced with either a small immediate reward or a large delayed reward. Self-report impulsivity scales are indirect subjective measures and are exposed to influences such as previous experiences (e.g., other people's comments about episodes of undesirable behaviour or reprimand experiences for behaving undesirably). Furthermore, staff ratings are open to subjective differences between staff and their personal experiences of the individuals whose behaviour they are rating.

Similarly, behavioural observations were highly influenced by situational factors such as peer influences, teacher absence and the fact that they were being observed. Again, this, in addition to observation intervals in which pupils were removed from or left the classroom, was difficult to control and measure within the current research. Furthermore, as the observations were solely carried out by the experimenter, inter-observer reliability measures were not possible.

However, it could be argued that this ensured observation criteria remained the same for each observation, although experimenter bias could have affected the results, reducing the validity of observation data obtained.

Previous research has compared discounting behaviour and other impulsivity measures (including self-reports) in individuals with impulse control difficulties to measures of impulsivity in closely matched control participants (such as ADHD: e.g., Neef et al., 2005; or substance abuse: e.g., Madden et al., 1997). Such comparisons between adolescents with BESD and matched controls would have been valuable in the current project. However, due to the specific demographics, and mixed range of difficulties experienced by participants at the school, obtaining a group of matched controls would have been highly problematic. Given the limited number of pupils at the participating school, university students were recruited to test the DAA (R) CCT and determine overall session duration. Therefore, in absence of such a comparison group, the only comparison possible was between the adolescents with BESD and university students.

Although the CAMM and Junior I.6 were designed for use with children and adolescents they were administered to the university students and data were analysed. Students generally obtained average scores of 50 percent on the CAMM, but responses were a little more varied on the Junior I.6. However, it could be argued that such data had little value, as the scales were not designed for use with adults.

Self-reports were always administered after the CCT or SCT, making it possible that the validity of self-report scores was affected, as individuals may have responded hastily, with no regard for item details or their responses to enable the session to be over more quickly. Additionally, self-report scales are highly subjective and influenced by distorted perceptions of one's own traits (Ledgerwood, Alessi, Phoenix & Petry, 2009). For example, it is possible that the adolescents rated themselves based on information received about their behaviour from other individuals (such as members of staff and parents/carers) rather than rating their own views.

More detailed impulsivity ratings could have been obtained from using more comprehensive measures such as the Self-Control Rating Scale (SCRS; Kendall & Wilcox, 1979) or Conners parent and teacher questionnaires (Conners, 1990). However, such scales are time consuming, especially as there were a large number of participants each member of staff was asked to rate. Therefore, as we only required a single objective measure of general impulsivity for each participant in the present research, a simple 10-point scale was designed for use. Additionally, ratings could have been obtained from other individuals such as key workers and parents/carers. However, it is likely that large individual differences would have been present between parents/carers and between key workers as they only worked with specific groups of boys. Also, as most of the participants were enrolled on residential placements at the school, obtaining ratings from parents and carers would have been difficult.

It is possible that the lack of correlation between the discounting task and other measures might be due to inclusion of untypical discounting behaviour in the

analysis. Unlike Dixon, Marley and Jacobs (2003), the current research did not set discounting criteria for inclusion in the data. Dixon et al. found high variability in rates of discounting between gambling and non-gambling participants, with more gamblers producing untypical response patterns of stable or increasing IPs across delays than non-gamblers. Data were considered "consistent with delay discounting if the indifference points decreased at least twice across successive delay values and did not increase more than once across successive delay values" (p. 452 - 453), resulting in 20 percent of participant's data being excluded. One could question why typical discounting was not produced by several participants (most of whom were gamblers rather than non-gamblers). Furthermore, one could question the validity of excluding such variability in results, as individuals differ greatly in their behaviour surely it is important to include such variability.

Data in the current project highlighted inconsistencies between commonly used measures of impulsivity, including measures of delay tolerance, and behaviour in natural environments. This is consistent with findings from several previous studies in which inconsistencies between discounting tasks and self-report measures have been reported. One suggestion involves the possibility that different forms of impulsivity exist and such inconsistencies are because different measures assess these different forms (Reynolds, Ortengren, Richards and De Wit, 2006). Therefore, research to identify specific aspects of impulsivity would be useful to formulate reliable and valid measures and assist in the development of interventions to reduce impulsive responding. Similarly, as advised by Hoerger and Mace (2006) and Solanto et al. (2001), research into

impulsivity would benefit from increased comparison and application to natural environments, such as behaviour in the classroom.

To summarise, results from studies conducted in the present thesis showed large discrepancies between measures of impulsivity from one measure to another. Given that the reliability and validity of new impulsivity measures are often deduced from correlations with established impulsivity measures, such discrepancies are concerning. However, as suggested by Reynolds et al. (2006), Toner, Holstein and Hetherington (1977) and Mobini et al. (2007), differences between impulsivity data from different types of measures might suggest that different forms of impulsivity exist.

### **7.3.3 Relations between impulsivity and mindfulness**

Delay discounting has dominated research on impulsivity for many years. Options requiring choices between consequences that vary in size and delay are regularly presented to humans and animals within their everyday lives. For example, should the eagle catch the mouse now or wait to catch a rabbit? Should one eat crisps and chocolate snacks now or not eat them and increase the likelihood that one will be thinner in a few months? Should I spend money on those new shoes or save it for something more important later? Organisms frequently make choices towards the more immediately rewarding option, especially those with impulse control difficulties, including addictions such as gambling, smoking and substance abuse, and those with diagnoses such as ADHD.

Research and data presented in chapter 1 indicated that adolescents with BESD include individuals who often present highly impulsive behaviour that causes considerable barriers to learning. Efforts to improve the behaviour of such individuals has involved a variety of methods from behavioural interventions such as implementing a token economy (see Martin & Pear, 2007; Kazdin, 1994), to therapies such as cognitive behavioural therapy (Kendall & Braswell, 1993; Butler, Chapman, Forman & Beck, 2006; O'Conner & Creswell, 2008; Scholte & Van Der Ploeg, 2000; Nestler & Goldbeck, 2011).

As implementing an effective token economy in the school was not possible, it was important that pupils learned the skills necessary to control their own behaviour. Such skills could facilitate more effective self-regulation, providing individuals with better prospects to cope more independently in the absence of reward contingencies (as set in a token economy). The current research explored the possibility that highly impulsive individuals give less conscious thought to their behaviour. If thinking is a skill that could be trained, then it might be possible to reduce impulsive behaviour in adolescents with BESD.

As mentioned in chapter 1, research has suggested that some adolescents with BESD have a limited capacity to be aware of their own private events, such as thoughts and feelings. Such difficulties present a barrier to the effectiveness of therapeutic interventions such as cognitive therapy and CBT, due to the necessary component of accessing thoughts. Training individuals to think more and apply more conscious awareness to different aspects of the environment might facilitate the effectiveness of such interventions and improve adolescents' ability to effectively self-regulate.

Mindfulness is a technique that promotes increased focussed thought and the awareness of one's environment. Research has shown that mindfulness-based skills are trainable in a variety of populations, including those with impulse control difficulties such as aggressive behaviour (e.g., Heppner et al., 2008; Singh et al., 2006), smoking (e.g., Bowen & Marlatt, 2009) and individuals with ADHD (e.g., Smalley et al., 2009; Zylowska et al., 2008), and forms the basis of several therapeutic interventions such as ACT. Therefore, to increase thinking and the awareness of thoughts, we proposed that there might be a relationship between mindfulness and impulsivity.

If impulsive choices involve less conscious thought, then one might assume that such decisions are made more quickly than self-controlled choices. Previous evidence (e.g., McCown, Johnson & Shure, 1993; Mitchell, 1999; Kirkeby & Robinson, 2005) suggested the possibility that self-controlled choices (choosing to wait for larger reward) involve increased deliberation of options and subsequently larger response times than impulsive choices. On the other hand, impulsive choices were likely to be made faster as immediacy of reward was most valued. Therefore, to explore whether participants take longer to make self-controlled choices and respond more quickly when choosing more impulsively, response times (RTs) towards larger delayed rewards (RTLL) and response times towards smaller more immediate rewards (RTSS) were recorded during the CCT.

In support of findings from previous research, university students in Experiments 3 and 4 (part 1) showed mean RTLL (responses to larger delayed

rewards) to be slightly larger than mean RTSS (responses to immediate rewards), and Experiment 4 (parts I and II combined) showed mean RTLL and RTSS as similar. However, in contrast to the findings shown in previous studies mentioned earlier, Experiments 1, 2 and 5 (involving adolescents with BESD) showed mean RTSS to be slightly larger than mean RTLL. Therefore, adolescents with BESD took longer to respond to impulsive (SS) choices than self-controlled (LL) choices and University students took longer to respond to self-controlled (LL) choices than impulsive (SS) choices.

It is possible that adolescents with BESD were more inclined to choose LL rewards than the university students as they were more motivated to wait for the larger monetary reward, and consequently more reluctant to select SS, resulting in increased deliberation (larger RTSS) in choosing the SS reward. A similar theory could be proposed for the University students who were less motivated by the monetary reward, so were more inclined to choose the SS reward and less inclined to select LL, resulting in increased deliberation (larger RTLL) in choosing the LL reward. Further research could test this by asking participants to rate the quality of the reward at the beginning of the session and then assess whether the quality ratings and RTSS and RTLL are correlated.

If response times towards self-controlled choices are larger because they involve increased thought, it is possible that the adolescents with BESD took similar amounts of time to respond to LL and SS choices because they are less aware of their thoughts in general. In contrast, the university students responded more typically by taking longer to make more self-controlled choices than impulsive choices (on average) because they thought about the self-



controlled reward option more. Although this was not possible in the current thesis, it would be interesting to study whether choice response times increase following a mindfulness-based training intervention in adolescents with BESD.

Robles and Vargas (2007) reported findings to suggest larger RTs were produced as participants came closer to their IP due to increased consideration of the two reward options. However, analysis of the data in Experiment 5 offered only limited support for this theory as, although a few participants responded more slowly as the SS value converged on their IP, RT tended to be highly varied between choice trials for each individual. Furthermore, given the mixed sample of adolescents with BESD, it is possible that diagnoses and/or medication might have affected RT. Consequently, few conclusions can be drawn from the RT results, and further research is required to determine the relationship between RT and impulsivity.

As for all private events, measurement of conscious processing is difficult. Several mindfulness self-report scales have been developed, including a small number of scales for use with children and adolescents, such as the Child Acceptance and Mindfulness Measure (CAMM: Greco & Baer, 2005) administered in the present project. Few correlations were found between CAMM and CCT scores in university students, possibly as measures were developed for use with children rather than adults, but combined results for Experiment 4 found a negative correlation between the CAMM and the Junior I.6 impulsivity measure. Despite the problem of restricted range, Experiments 5, 6 and 7 each revealed negative correlations between the CAMM and the Junior I.6 in adolescents with BESD, suggesting that highly impulsive individuals

produced low mindfulness scores. Furthermore, in Experiment 6 the CAMM was positively correlated with class attendance and negatively correlated with staff impulsivity ratings and inattentive behaviour in the classroom.

Evidence from Experiment 6 suggested poor test-retest reliability of the CAMM therefore, as it was necessary to repeatedly administer the mindfulness and impulsivity self-report measures in Experiment 7, the MAAS (Brown & Ryan, 2003) was also administered to explore correlations between measures. Several correlations between impulsivity and mindfulness measures were found between the CAMM, MAAS, Junior I.6, BSCS, COC, attendance, physical interventions, SCT and PDT. Therefore, results from experiments in the current thesis suggest that highly impulsive individuals are generally less mindful.

In further support of such a relation, the mindfulness intervention administered in Experiment 7 reduced undesirable classroom behaviour and the rate at which some participants discounted. Therefore, this provided evidence in support of previous research (e.g., Bögels et al., 2008; Zylowska et al., 2008; Smalley et al., 2009; Heppner et al., 2008; Singh et al., 2006) to suggest a beneficial effect of mindfulness-based exercises in increasing the awareness of thought in adolescents with BESD. Impulsivity has been considered a common difficulty in the effective self-regulation of behaviour (Wulfert, Block, Santa Ana, Rodriguez & Colsman, 2002). Therefore, reducing impulsive responding by increasing mindful awareness is likely to facilitate more effective self-regulation of behaviour in individuals with impulse control difficulties. However, it is important to consider the population sample targeted and provide appropriate training exercises.

Although the content of the mindfulness sessions varied between participants to suit pupils' preferences, not all participants benefited from the mindfulness training. It is possible that this was because the number of sessions was too few for some participants, especially for those who withdrew from the study, or because training was not specific enough to focus on behaviour change in the classroom. Nonetheless, due to the relative success of the intervention for several participants in Experiment 7, one could maintain that the mindfulness-based training exercises adopted in the intervention were appropriate for use with adolescents with BESD.

As mentioned in detail in chapter 6, Bögels et al. (2008) experienced several issues concerning non-compliance and distractions within group mindfulness sessions. As a result, Experiment 7 in the present project administered mindfulness sessions on a one-to-one basis lasting between 30 and 45 minutes (rather than the 1.5 hour sessions carried out by Bögels et al.). This enabled the experimenter to deliver short mindfulness exercises (especially important given the possible attention difficulties in adolescents with BESD) and act as an appropriate role-model, re-focussing adolescents when necessary during the mindfulness practices. In comparison to the problems faced by Bögels et al., it appeared that individual sessions were more effective at facilitating mindfulness practice as individuals were less distracted by peers and felt less embarrassed practising with the experimenter.

Benefits of group sessions are large, enabling individuals to practice and discuss mindfulness experiences openly with peers. Nevertheless, and in

support of a suggestion by Bögels et al., since adolescents with BESD might be concerned with other's opinions of them (e.g., feelings of embarrassment mentioned by P622 in Experiment 7, see section 6.4), it is advisable to start sessions individually until mindfulness practice is familiar. Following this, it might be possible to gradually increase the number of participants within the sessions, with careful evaluation of behaviour between members of the group. In the absence of initial individual sessions, it is considered likely that adolescents will fail to comply, or withdraw.

It seems reasonable to propose that mindfulness strategies might help individuals develop techniques to deal more appropriately with situations that would normally bring about problem behaviour, as they promote awareness of the present moment non-judgementally. Such focus was included in Bögels et al.'s study, and it could be argued that focus on specific difficult experiences might provide adolescents with a better understanding of how to respond to such situations. Alternatively, it could be that mindfulness promotes awareness of conscious thought rather than acting on unconscious urges. Impulsivity involves immediate gratification, whereas mindfulness involves increased awareness of the situation. It seems possible that mindfulness skills increase an individual's ability to wait for a delayed reward by removing the aspect of reward directed attention and instead, focussing on aspects of the present moment. In support of this, Toner, Lewis & Gribble (1979) found that children who verbalised a present moment, positive task oriented statement ('I like to wait') waited longer than children who verbalised reward directed statements ('I like the tokens') that increased awareness of future profit. Similarly, Mischel and

Ebbesen (1970) found that reward directed attention was detrimental to situations in which an individual is required to wait for that reward.

However, mindfulness requires practise, and individuals have difficulty training themselves to become mindfully aware of specific events, such as the sensations and observations one can make in the mindful breathing exercise. As reported in chapter 1 of the current thesis, adolescents with BESD include those diagnosed with Autism Spectrum Disorders (ASD). Individuals with ASD have been reported to have difficulties attributing mental states to themselves and others (Frith & Happé, 1999; Burton & Mitchell, 2003). Therefore an initial consideration of the current project concerned whether individuals with BESD, and in particular those with ASD, would be capable of engaging in mindfulness-based exercises.

Of the three participants in Experiment 7 who had ASD, two reported that the mindfulness exercises became easier to perform, two scored higher on the MAAS post-intervention (but only one participant increased his CAMM and BSCS scores post-intervention), and all showed decreased undesirable behaviour post-intervention which continued in follow-up observations. Therefore, in support of research by Frith and Happé (1999) and Thompson (2008), research in the current thesis indicates the possibility that high functioning individuals with ASD can present increased mindfulness through training. Furthermore, the findings suggest that such focussed awareness and thinking can be trained as a skill with adolescents with disorders such as ADHD and ASD. As the training was only for 7 weeks it is possible that an extended mindfulness-based intervention would have produced a more substantial effect.

Although it appeared there were no relations between diagnosis and discounting or between diagnosis and mindfulness, such correlations were difficult to assess due to the wide range of diagnoses and complex multiple diagnoses. Dividing participants into groups of individuals with specific diagnoses produced very small sample sizes, and therefore was not beneficial to explore whether diagnoses were correlated with mindfulness and impulsivity. Similarly, it was difficult to determine the effect of medication on delay discounting, self-reported impulsivity and mindfulness as the medication for several participants was altered throughout testing and several participants received a variety of different combinations of medication. Assessing impulsivity in individuals with specific diagnoses might be possible with a larger number of participants, or by recruiting participants with the same diagnosis (e.g., ASD). Additionally, with participants' medications, points at which baselines and interventions occurred could have been plotted and compared with other measures to explore the effects of medication on participants' responding.

There was likely to be large variance in the ability of adolescents to reliably report mindful functioning, so it was important in the final experiment to analyse data on a case-by-case basis. O'Brien, Larson and Murrell (2008) suggested parents as the best source of information as they have knowledge of their child's behaviour across time and situation. However, most participants in the current thesis were enrolled on residential placements, therefore it was difficult to obtain such information from parents and carers, especially in Experiment 7 in which repeated measures were conducted throughout the school term, and it was likely that parents/carers would have not seen their child from one test date

to the next. Kazdin (1994) however, argued parent reports are highly situational and subsequently are not without error, therefore more reliable information is likely to be obtained through reports from multiple individuals.

The two mindfulness measures used within the current thesis (the CAMM and MAAS) were relatively new and their infrequent use in previous research must be considered. Due to the relatively novel application of mindfulness and ACT to children and adolescents, the reliability and validity of these measures is not yet well established. Within the current thesis, the CAMM lacked sufficient test-retest reliability to enable repeated testing (as necessary in Experiment 7) therefore, it could be argued that CAMM scores in Experiment 7 are unreliable. Sufficient test-retest reliability of scales would be useful in such multiple-baseline designs in which repeated testing is required, therefore there is a need for alternative mindfulness measures with high test-retest reliability, suitable for children and adolescents, parents and teachers.

Due to time constraints, the mindfulness-based intervention was restricted to 7 weeks, pre- and post-intervention phases were 4 weeks each, and follow-up data was limited. Furthermore, due to missed sessions some participants did not complete the post-intervention control phase and follow-up data was only obtained for three of the six participants. Therefore, although results in Experiment 7 are preliminary and only suggestive of potentially beneficial effects of mindfulness-based therapy in reducing impulsive responding in adolescents with BEDS, such positive effects within a short duration seem promising. However, while the present findings are consistent with those of

Bögels et al., more compelling data might have been obtained if more time had been available for training.

Behavioural, emotional and social difficulties (BESD) consist of a considerable variety of diagnoses, including Autism Spectrum Disorders (ASD), Attention Deficit Hyperactivity Disorder (ADHD), Aspergers Syndrome (AS), Conduct Disorder (CD), Oppositional Defiant Disorder (ODD), Tourettes, Pathological Demand Avoidance Syndrome, Schizophrenia, and severe and complex learning needs. For this reason, although Experiment 7 suggested mindfulness can be increased in adolescents with ASD, it was not possible to draw concrete conclusions about impulsive and mindful responding of individuals with other specific diagnoses. As also suggested by Bögels et al. (2008), it would be interesting to learn more about individuals with specific diagnosis regarding impulsive choice and mindfulness, and highly valuable to developing effective interventions.

Interventions for individuals with BESD are often ineffective (Bögels et al., 2008), therefore implementation of novel therapeutic strategies are fundamental to improving the future prospects of such individuals. As results within the current thesis suggest, it is possible that mindfulness-based training could improve individuals' self-control and encourage more effective behavioural self-regulation (Mischel, Shoda & Rodriguez, 1989). Furthermore, for individuals who have difficulties accessing their private events such as thoughts, beliefs and feelings, developing their awareness of their thoughts and the capacity of thinking through training could facilitate the effectiveness of therapeutic interventions such as CBT. From the beneficial effects observed in Experiment



7, it seems possible that thinking is a skill that can be taught, and that increased thinking might reduce impulsive behaviour in adolescents with BESD.

As the current findings are preliminary, further research is required to assess the relation between impulsivity and mindfulness and examine the beneficial effects of mindfulness on adolescents with BESD. Investigation into strategies and exercises that can effectively be applied to the development of mindfulness in children, adolescents, parents, carers, key workers and teachers in mindfulness-based training would be valuable. In addition, more detailed follow-up data is necessary to determine the long-term effects of mindfulness-based training on adolescents with BESD. Although mindfulness exercises in Experiment 7 were carried out during individual sessions, further beneficial effects might be produced through group therapy sessions.

#### **7.4 Conclusion**

Two main issues have developed from this research. Firstly, results from studies conducted in the present thesis showed large discrepancies between different measures of impulsivity. Although it is likely that the small and heterogeneous samples resulted in underpowered statistical analyses, similar findings have been reported in other empirical research. It has been suggested that differences between impulsivity data from different types of measures, might suggest that different forms of impulsivity exist. However, since the reliability and validity of new impulsivity measures are often deduced from correlations with established impulsivity measures, such discrepancies remain a cause for concern.

Furthermore, reviews of previous research, and studies carried out within this thesis, have emphasised the sensitivity of impulsive responding to slight differences between the features of impulsivity measures. In support of this was the finding that impulsive choice in adolescents with BESD was dependent on task type and context. Given the large amount of research that has based its findings on such tasks, one could question the validity and generalisability of such work. It is necessary therefore, to investigate whether different forms of impulsivity do exist, and if so, to establish more specific, standardised measures to assess each impulsivity subtype. Such research would increase our understanding and enable more effective measurement and treatment of impulsive behaviour.

The second issue to have emerged from this research is that thinking is a skill, that appears possible to be effectively trained in adolescents with BESD. Although mindfulness forms a part of therapeutic interventions such as ACT, for purposes of this research it was used to develop thinking and the awareness of thoughts. Findings from studies in this thesis suggest that impulsivity and mindfulness are related, and highlight the potential benefits of mindfulness training to facilitating the effectiveness of interventions such as CBT. The benefits of mindfulness training to increase focussed thought deserves further consideration in promoting effective self-regulation in adolescents with BESD.



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## **Appendices**

## Appendix A

### Faculty of Science



Portland Square A106, Plymouth

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To:	Jessica Bradford	From:	Christine Brown
cc:	Dr Phil Gee		Secretary to Human Ethics Committee
Your Ref:		Our Ref:	sci:\d:\human ethics:
Date:	17 April 2007	Phone Ext:	2762

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#### **Application for Ethical Approval**

Thank you for submitting the ethical approval form and details concerning your project:

'Reflective ability and therapeutic effectiveness in adolescents with emotional and behavioural difficulties'

I am pleased to inform you that this has been approved.

Kind regards

Christine Brown

## Appendix B

20<sup>th</sup> April 2007

Dear Parent/Carer/Legal Guardian,

I am a Psychology PhD student from the University of Plymouth and have been working at **[omitted for reasons of confidentiality]** for 6 months.

The research title I am working on is '*Reflective Ability and Therapeutic Effectiveness in Adolescents with Emotional and Behavioural Difficulties*'. This will be a long term project (over 3 years) focussing on adolescents behaviour, thoughts and therapy.

Specifically, we intend to increase knowledge in this area of psychology through studying pupils' impulsive behaviour and their ability to reflect (think about their own thoughts and feelings). In examining these 2 areas, we intend to look at, and promote knowledge to enable professionals to improve the effectiveness of therapy for these individuals.

The proposal for this research has been submitted to and approved by both the staff at **[omitted for reasons of confidentiality]** and by the Ethics Committee of the Faculty of Science at the University of Plymouth. All information collected in the research will remain confidential and anonymous. I will also explain the research to each pupil and inform them that it is not compulsory that they take part and they can withdraw at any time.

Please read the attached Information Sheet (explaining the research in more detail) and Consent Form. If you have any questions or would like more information please contact the school (they will be able to contact me).

### **IMPORTANT INFORMATION**

**After 10 working days of you receiving this, your child will be invited to take part in this research.**

**ONLY if you do not wish your child to take part in this research please sign the lower part of the 'Consent Form for Legal Guardian' and return it to the above address WITHIN 10 WORKING DAYS OF RECEIVING THIS. In this case your child will not be invited to take part.**

Regards

Miss Jessica Bradford BSc (Hons)

## **INFORMATION SHEET FOR LEGAL GUARDIAN UNIVERSITY OF PLYMOUTH, FACULTY OF SCIENCE**

Name of Principal Investigator: Jessica Bradford

Title of Research: Reflective Ability and Therapeutic Effectiveness in Adolescents with Emotional and Behavioural Difficulties.

Aims of research:

1. Measure impulsiveness/self-control.
2. Measure reflective ability (ability to think about own thoughts/feelings/emotions).
3. Compare scores for each participant to determine whether impulsiveness is related to reflective ability.
4. If there is a relationship, use skills training to improve reflective ability.
5. Study the effect of reflectiveness training by examining scales and choice task performance, in addition to teacher/carer reports.

Description of procedure: Pupils will perform a computer task. They will be asked to choose between 2 tasks. 1 task will have a short delay to a small reinforcer, the other task will have a long delay to a larger reinforcer. Pupils will chose between the tasks throughout a sequence. Their choices will be examined to determine their levels of impulsiveness/self-control.

Questionnaires will also be used to additionally measure impulsiveness and reflective ability (i.e. pupils' abilities to think about their own thoughts and feelings). The scores that they obtain on these questionnaires will then be compared to their scores on the choice task to determine the relationship between impulsiveness and reflectiveness. If there appears to be a relationship between impulsiveness and reflectiveness pupils will undergo reflective skills training given by the researcher. The effect of this training will be assessed through further choice tasks, scales and/or teacher/carer reports.

Description of risks: There are no perceived risks.

Benefits of proposed research: To produce accurate measures of impulsiveness and reflective ability that can be widely used and determine whether reflection and impulsive behaviour are related. To establish whether reflection is vital in therapy and consequently find out whether it is a skill that can be taught. We aim to improve the effectiveness of therapy for this population, with the principle aim of improving reflective ability to subsequently increase self control. Overall, we hope to learn more about the influence of such factors, and subsequently increase knowledge to enable professionals to prepare this population for the future.

Right to withdraw: Participants hold the right to withdraw from the study at any time throughout the research.

If you are dissatisfied with the way the research is conducted, please contact the principal investigator in the first instance: telephone number 01752 233189. If you feel the problem has not been resolved please contact the secretary to the Faculty of Science Human Ethics Committee: Ms Christine Brown 01752 232762.

**CONSENT FORM FOR LEGAL GUARDIAN**

**UNIVERSITY OF PLYMOUTH, FACULTY OF SCIENCE  
Human Ethics Committee Consent Form**

**CONSENT TO PARTICIPATE IN RESEARCH PROJECT**

Name of Principal Investigator: Miss Jessica Bradford

Title of Research: Reflective Ability and Therapeutic Effectiveness in Adolescents with Emotional and Behavioural Difficulties.

Purpose of work: Participants will be asked to perform a number of short tasks to find out their level of impulsiveness/self-control. They will then complete questionnaires to find out their reflective ability (i.e. their ability to think about their own thoughts and feelings). This will help us find out if there is a relationship between impulsiveness and the ability to reflect. We think that people have different levels of impulsiveness and reflectiveness.

Lots of therapies require people to reflect, and so are likely to be ineffective to people with low reflective ability. We would like to reduce impulsivity and increase self control. Thus, if there is a relationship between reflective ability and impulsive behaviour then we may be able to train people to improve their reflective skills. We will therefore aim to train reflectiveness (administered by the therapeutic team at the schools) and then study its effect on impulsiveness. This will be examined through additional choice tasks, scales and teacher/carer reports.

---

***IMPORTANT*** If you ***do not*** wish for your child to take part in this research then please sign and return this section within 10 working days of receiving it. Many thanks.

I am the parent /legal guardian of.....

I do not wish for him to participate in this research.

Name: .....

Signature: ..... Date: .....



## Appendix C

16<sup>th</sup> September 2008

Dear Parent/Carer/Legal Guardian,

I am a Psychology PhD student from the University of Plymouth and have been working at **[omitted for reasons of confidentiality]** for 2 years.

My research title is '*Reflective Ability and Therapeutic Effectiveness in Adolescents with Emotional and Behavioural Difficulties*'. This is a 3 year project focussing on adolescents' behaviour, thoughts and therapy.

Specifically, we intend to increase knowledge in this area of psychology through studying pupils' impulsive behaviour and their ability to reflect (think about their own thoughts and feelings). In examining these 2 areas, we intend to look at, and promote knowledge to enable professionals to improve the effectiveness of therapy for these individuals.

This research has been approved by both the staff at **[omitted for reasons of confidentiality]** and by the Ethics Committee of the Faculty of Science at the University of Plymouth. All information (including pupils' age, diagnoses and medication) collected in the research will remain confidential and anonymous. I will also explain the research to each pupil and inform them that it is not compulsory that they take part and they can withdraw at any time.

Please read the attached Information Sheet (explaining the research in more detail) and Consent Form. If you have any questions or would like more information please contact the school (they will be able to contact me).

### **IMPORTANT INFORMATION**

**After 10 working days of you receiving this, your child will be invited to take part in this research.**

**ONLY if you do not wish your child to take part in this research please sign the lower part of the 'Consent Form for Legal Guardian' and return it to the above address WITHIN 10 WORKING DAYS OF RECEIVING THIS. In this case your child will not be invited to take part.**

Kind Regards

Miss Jessica Bradford BSc (Hons)



## **INFORMATION SHEET**

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** Reflective Ability and Therapeutic Effectiveness in Adolescents with Emotional and Behavioural Difficulties.

**Aims of research:**

1. Measure impulsiveness/self-control.
2. Measure reflective ability (ability to think about own thoughts/feelings/emotions).
3. Compare scores for each participant to determine whether impulsiveness is related to reflective ability.
4. If there is a relationship, use skills training to improve reflective ability.
5. Study the effect of reflectiveness training by examining scales and choice task performance, in addition to teacher/carer reports.

**Description of procedure:** Pupils will perform a computer task. They will be asked to choose between 2 tasks. 1 task will have a short delay to a small reward, the other task will have a long delay to a larger reward. Pupils will chose between the tasks throughout a sequence. Their choices will be examined to determine their levels of impulsiveness/self-control.

Questionnaires will also be used to additionally measure impulsiveness and reflective ability (i.e. pupils' abilities to think about their own thoughts and feelings). The scores that they obtain on these questionnaires will then be compared to their scores on the choice task to determine the relationship between impulsiveness and reflectiveness. If there appears to be a relationship between impulsiveness and reflectiveness pupils will undergo reflective skills training given by the researcher. The effect of this training will be assessed through further choice tasks, scales and/or teacher/carer reports.

**Description of risks:** There are no perceived risks.

**Benefits of proposed research:** To produce accurate measures of impulsiveness and reflective ability that can be widely used and determine whether reflection and impulsive behaviour are related. To establish whether reflection is vital in therapy and consequently find out whether it is a skill that can be taught. We aim to improve the effectiveness of therapy for this population, with the principle aim of improving reflective ability to subsequently increase self control. Overall, we hope to learn more about the influence of such factors, and subsequently increase knowledge to enable professionals to prepare this population for the future.

**Right to withdraw:** Participants hold the right to withdraw from the study at any time throughout the research.

If you are dissatisfied with the way the research is conducted, please contact the principal investigator in the first instance: telephone number 01752 233189. If you feel the problem has not been resolved please contact the secretary to the Faculty of Science Human Ethics Committee: Ms Christine Brown 01752 232762.



## **CONSENT FORM**

Name of Principal Investigator: Miss Jessica Bradford

Title of Research: Reflective Ability and Therapeutic Effectiveness in Adolescents with Emotional and Behavioural Difficulties.

Purpose of work: Participants will be asked to perform a number of short tasks to find out their level of impulsiveness/self-control. They will then complete questionnaires to find out their reflective ability (i.e. their ability to think about their own thoughts and feelings). This will help us find out if there is a relationship between impulsiveness and the ability to reflect. We think that people have different levels of impulsiveness and reflectiveness.

Lots of therapies require people to reflect, and so are likely to be ineffective to people with low reflective ability. We would like to reduce impulsivity and increase self control. Thus, if there is a relationship between reflective ability and impulsive behaviour then we may be able to train people to improve their reflective skills. We will therefore aim to train reflectiveness (administered by the therapeutic team at the schools) and then study its effect on impulsiveness. This will be examined through additional choice tasks, scales and teacher/carer reports.

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***IMPORTANT*** If you ***do not*** wish for your child to take part in this research then please sign and return this section within 10 working days of receiving it. Many thanks.

I am the parent /legal guardian of.....

I do not wish for him to participate in this research.

Name: .....

Signature: ..... Date: .....

## Appendix D

### CONSENT TO PARTICIPATE IN RESEARCH

#### PARTICIPANT CONSENT FORM

Experiments 1 and 2

UNIVERSITY OF PLYMOUTH

FACULTY OF SCIENCE

#### Human Ethics Committee Consent Form

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** Reflective Ability and Therapeutic Effectiveness in Adolescents with Emotional and Behavioural Difficulties.

**Task 1: Choose small rewards immediately or large rewards later?**

You will be asked to play a computer game. The game is to shoot spaceships. The spaceships have different amounts of money. You can choose which spaceship you want to shoot. Spaceships with the highest points will usually be furthest away. You will be given the amount of money you got in the game.

I will look at which spaceships you chose to shoot to see how impulsive you were.

---

- This research has been explained to me.
- I understand that I don't have to do this and that I can stop at any time.
- If I don't want anyone to see what I did then I can ask for this paper to be destroyed.
- I understand that information about me is private and other people who are not part of this study will not be told anything about me or my score.

If this is true then I will play the spaceship computer game.

Name: .....

Signature: ..... Date: .....

## Appendix E

### Instructions, brief and debrief (Experiments 1 & 2)

#### **Brief**

Hello, my name is Jess. I work for the University of Plymouth. You have been invited to help me with my work. I will ask you to play a spaceship computer game. I am interested in your choices. This is not a test. There are no correct answers. Tell me if you want to stop playing the game. No-one will know your choices. If you don't want me to use your choices in my work then tell me (or your key worker) today or in the next 2 weeks. Do you have any questions?

#### **Instructions (Computer Choice Task)**

- There are 2 spaceships worth money (1=1p).
- The amount of money will change.
- There is a gun at the bottom of the screen that moves.
- The gun will be nearer 1 of the spaceships.
- When you shoot the spaceship there will be a big BANG!
- You will be given the amount of money for each spaceship that you shoot.
- The money will be put into the jar next to the screen.

#### **Practice Instructions**

- This is the practice game with pretend money.
- There are 5 practice trials.
- Press the 'FIRE' button (*experimenter to show button to participant*) to move the gun.
- The gun will shoot automatically.
- You cannot choose which spaceship to shoot.

#### **Main Instructions**

- You will play the real game now.
- You have 20 trials to get as much money as you can.
- You can choose any spaceship by moving the stick towards the spaceship you want.
- You don't have to press any button to shoot.
- The countdown clock will show you how long you have to make your choice.
- You will be told the total amount of money you got at the end of the game.

#### **Debrief**

Thank you for playing Jess' spaceship computer game. I will look at your choices. This will tell me how impulsive your choices were. There were no correct answers. Only the main researchers will see your choices and your name will remain unknown. You will be asked to play it again.

If you have any questions or don't want me to use your choices in my work then tell your key worker (they will tell me). Thank you for helping me with my work.

## Appendix F

### Faculty of Science



Portland Square A106, Plymouth

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To:	Jessica Bradford	From:	Christine Brown
cc:	Dr Phil Gee		Secretary to Human Ethics Committee
Your Ref:		Our Ref:	sci:\d:\human ethics:
Date:	5 November 2007	Phone Ext:	32762

---

#### Application for Ethical Approval

Thank you for submitting the ethical approval form and details concerning your project:

'An investigation into behavioural measures of impulsive choice'

I am pleased to inform you that this has been approved.

Kind regards

Christine Brown

## Appendix G

### CONSENT TO PARTICIPATE IN RESEARCH PROJECT (*Experiment 3*)

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** An Investigation into Measures of Choice Behaviour

**Brief (Statement of purpose of work):** The main purpose of this research is to examine different measures choice behaviour. You will be invited to complete 4 choice tasks on 2 slightly different computer programs and then you may be asked to complete some questionnaires. This will take no longer than 1 hour in total and you will receive 2 participation points for participating. Additionally, you will receive a monetary amount which is dependent on the choices you make in the computer choice tasks.

For the computer choice tasks you will be asked to play a simple game that will require you to shoot 1 of 2 spaceships presented on a screen. The spaceships will be worth different amounts of money and it may take longer to shoot 1 of the spaceships. I am interested in the choices you make.

The questionnaires will be given after the computer choice tasks and include questions regarding your everyday behaviour and thoughts.

This is not a test. There are no correct answers. Please let the experimenter know if you want to stop at any stage of the experiment. Your choices will remain anonymous throughout this study and you are permitted to withdraw your data at any point during this study and up to 2 weeks after. If you do decide that you wish to withdraw yourself or your data from this research then please let the experimenter know ([jessica.bradford@plymouth.ac.uk](mailto:jessica.bradford@plymouth.ac.uk)).

Do you have any questions?

- 
- The objectives of this research have been explained to me.
  - I understand that I am free to withdraw from the research at any stage, and ask for my data to be destroyed if I wish.
  - I understand that my anonymity is guaranteed, unless I expressly state otherwise.
  - I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks, and that safety and health risks will have been separately assessed by appropriate authorities.

Under these circumstances, I agree to participate in the research.

Name: ..... Age: .....

Signature: ..... Date: .....

## Appendix H

### **INFORMATION and INSTRUCTION SHEET**

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** An Investigation into Measures of Choice Behaviour.

**Aim of research:** Investigate methodological procedures that measure choice behaviour.

**Description of procedure:**

You will be asked to complete 8 slightly different choice tasks in a computer game. You will be presented with 2 spaceships on a computer screen. Each spaceship is worth different amounts of *real* money (1 point = 1p). You will receive the money associated to the chosen spaceship after it has been shot (placed in a transparent container by the experimenter). There is a gun at the bottom of the screen that you can move left or right (using the joystick) to get below the spaceship you want to shoot. It will take longer to get below one spaceship than the other. The gun will move and shoot automatically when you have made your choice. You will be given a practice task of 6 trials. Your choices over a sequence of trials will be recorded and compared between the different tasks that you completed. It is not a test we are just interested in the choices that you make. On completing the choice tasks you may additionally be asked to complete a questionnaire. If you have any questions during the study then please ask. It will take no longer than 1 hour in total and you will get 2 points for participating, in addition to the money gained from shooting the spaceships.

**Benefits of proposed research:** Data will provide information indicating the most effective way of presenting this computer choice task. This research will be used to conduct further research in behaviour of adolescents with emotional and behavioural difficulties.

**Description of risks:** No perceived risks associated with this research at this time.

**Right to withdraw:** You have the right to withdraw at any point during this study and up to 2 weeks after. If you do decide that you wish to withdraw yourself or your data from this research then please let the experimenter know ([jessica.bradford@plymouth.ac.uk](mailto:jessica.bradford@plymouth.ac.uk)).

If you are dissatisfied with the way the research is conducted, please contact the principal investigator in the first instance: telephone number 01752 233131. If you feel the problem has not been resolved please contact the secretary to the Faculty of Science Human Ethics Committee: Ms Christine Brown 01752 232762.



### **Verbal Instructions (from experimenter)**

- You will see 2 spaceships – 1 each side of the screen – each with a number underneath (this is the amount of money the spaceship is worth).
- You choose the spaceship you want to shoot by moving the stick in the direction of the desired spaceship – this moves the gun at the bottom of the screen.
- You don't have to aim or shoot as this will happen automatically after you have chosen the spaceship.
- Once you have moved the stick, the gun will move in that direction – if you wish to change direction then tell the experimenter who will re-start the choices on that trial (this cannot be done by moving the stick in the opposite direction).
- You will be given 60 seconds to make your choice - the countdown timer in the centre of the screen indicates the time you have left to choose.
- There are no other time restrictions.
- You will always be required to make 6 choices per trial.
- We will start the practice. You will not receive the money shot in the practice, but please try to make choices as though it is real money.

Do you have any questions?

## Appendix I

### Debrief

- ***Thank you for participating in this research!!*** I will look at the choices that you made in the computer choice task and the answers you gave in the questionnaires.
- The computer choice task (the spaceship game) in this research was a behavioural measure of impulsive/self-controlled choice. The options you were presented with included either a short delay to a small monetary reward or a longer delay to a larger monetary reward. For this task, an impulsive choice would have been made when the smaller short delayed reward was chosen over the larger reward that was available after a longer delay. On the other hand, a more self-controlled choice would have been made when the larger longer delayed reward was chosen. All the choices you made were recorded by the computer in addition to the amount of time you took to make your choice.
- The amount of money associated with the delayed reward was always 10p in each trial. The amount of money associated with the shorter delayed reward always started at 5p but was then adjusted in proceeding trials depending on the previous choice you made. You were presented with 4 different time delays to the larger reward for 2 slightly different programs: 1 program presented whole monetary amounts; the other presented fractional monetary amounts to you.
- The data from the 2 programs will be compared in order to determine which program would be most suitable to be used for further research. In addition, the Junior I.6 questionnaire will be used to establish the reliability of the computer tasks in measuring impulsiveness/self-controlled choice. Answers from the CAMM (if time permitted) will be compared to levels of impulsivity to determine whether there are any relationships between thinking about your thoughts and feelings and levels of impulsive choice behaviour.
- There were no correct answers. Only the main researchers in this research will see your choices and you will remain anonymous throughout. If you wish for yourself or your data to be withdrawn from the research then please let the experimenter know (see details below). Additionally, please feel free to contact the experimenter regarding any future questions you may have regarding the experiment.

Do you have any questions?

**Principle Investigator:** Jessica Bradford  
Email: [jessica.bradford@plymouth.ac.uk](mailto:jessica.bradford@plymouth.ac.uk)

Phone: 01752 233131  
Room: LB221

## Appendix J

### CONSENT TO PARTICIPATE IN RESEARCH PROJECT (Experiment 4)

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** An Investigation into Measures of Choice Behaviour

**Brief (Statement of purpose of work):**

The main purpose of this research is to examine different measures choice behaviour. You will be invited to complete 4 choice tasks on a computer and then asked to complete 2 questionnaires. This will take no longer than 30 minutes in total and you will receive 1 participation point for participating. Additionally, you will receive a monetary amount which is dependent on the choices you make in the computer choice task.

For the computer choice tasks you will be asked to play a simple game that will require you to shoot 1 of 2 spaceships presented on a screen. The spaceships will be worth different amounts of money and it may take longer to shoot 1 of the spaceships. I am interested in the choices you make.

The questionnaires will be given after the computer choice tasks and include questions regarding your everyday behaviour and thoughts.

This is not a test. There are no correct answers. Please let the experimenter know if you want to stop at any stage of the experiment. Your choices will remain anonymous throughout this study and you are permitted to withdraw your data at any point during this study and up to 2 weeks after. If you do decide that you wish to withdraw yourself or your data from this research then please let the experimenter know ([jessica.bradford@plymouth.ac.uk](mailto:jessica.bradford@plymouth.ac.uk)).

Do you have any questions?

- 
- The objectives of this research have been explained to me.
  - I understand that I am free to withdraw from the research at any stage, and ask for my data to be destroyed if I wish.
  - I understand that my anonymity is guaranteed, unless I expressly state otherwise.
  - I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks, and that safety and health risks will have been separately assessed by appropriate authorities.

Under these circumstances, I agree to participate in the research.

Name: .....

Signature: ..... Date: .....

## Appendix K

### **INFORMATION and INSTRUCTION SHEET**

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** An Investigation into Measures of Choice Behaviour.

**Aim of research:** Investigate methodological procedures that measure choice behaviour

**Description of procedure:**

You will be asked to complete 4 choice tasks on a computer. You will be presented with 2 spaceships on a computer screen. Each spaceship is worth different amounts of *real* money (1 point = 1p). After a spaceship has been shot, the amount of money on that spaceship will be placed in a transparent container by the experimenter. This money will be given to you at the end of the experiment in addition to 1 participation point. There is a gun at the bottom of the screen that you move left or right (using the joystick) to get to the spaceship you want to shoot. It will take longer to get to one spaceship than the other. After moving the joystick left or right to the spaceship you have chosen to shoot, the gun will move and shoot automatically. You can change your choice at any time (in order to do this, let the experimenter know so that the set of choices can be re-started for you). You will be given a practice task of 6 trials (you will not receive the money in these trials, but please make choices as you would with *real* money). Your choices over a sequence of trials will be recorded and compared between the different tasks that you completed. It is not a test we are just interested in the choices that you make.

On completing the choice tasks you will be asked to complete 2 questionnaires.

If you have any questions during the study then please ask. It will take no longer than 30 minutes in total and you will get 1 point for participating, in addition to the money from the spaceships you chose to shoot.

**Benefits of proposed research:** Data will provide information indicating the most effective way of presenting this computer choice task. This research will be used to conduct further research in behaviour of adolescents with emotional and behavioural difficulties.

**Description of risks:** No perceived risks associated with this research at this time.

**Right to withdraw:** You have the right to withdraw at any point during this study and up to 2 weeks after. If you do decide that you wish to withdraw yourself or your data from this research then please let the experimenter know ([jessica.bradford@plymouth.ac.uk](mailto:jessica.bradford@plymouth.ac.uk)).

If you are dissatisfied with the way the research is conducted, please contact the principal investigator in the first instance: telephone number 01752 233131. If you feel the problem has not been resolved please contact the secretary to the Faculty of Science Human Ethics Committee: Ms Christine Brown 01752 232762.

### **Verbal Instructions (from experimenter)**

- You will see 2 spaceships – 1 each side of the screen – each with a number underneath (this is the amount of money the spaceship is worth).
- You choose the spaceship you want to shoot by moving the stick in the direction of the desired spaceship – this moves the gun at the bottom of the screen.
- You don't have to aim or shoot as this will happen automatically after you have chosen the spaceship.
- Once you have moved the stick, the gun will move in that direction – if you wish to change direction then tell the experimenter who will re-start the choices on that trial (this cannot be done by moving the stick in the opposite direction).
- You will be given 60 seconds to make your choice - the countdown timer in the centre of the screen indicates the time you have left to choose.
- There are no other time restrictions.
- You will always be required to make 6 choices per trial.
- We will start the practice. You will not receive the money shot in the practice, but please try to make choices as though it is real money.

Do you have any questions?

## Appendix L

### Debrief

- ***Thank you for participating in this research!!*** I will look at the choices that you made in the computer choice task and the answers you gave in the questionnaires.
- The computer choice task ('Space Warrior') in this research was a behavioural measure of impulsive/self-controlled choice. The options you were presented with included either a short delay to a small monetary reward or a longer delay to a larger monetary reward. For this task, an impulsive choice would have been made when the smaller short delayed reward was chosen over the larger reward that was available after a longer delay. On the other hand, a more self-controlled choice would have been made when the larger longer delayed reward was chosen. All the choices you made were recorded by the computer in addition to the amount of time you took to make your choice.
- The amount of money associated with the delayed reward was always 10p in each trial. The amount of money associated with the shorter delayed reward always started at 5p but was then adjusted in proceeding trials depending on the previous choice you made. You were presented with 4 different time delays to the larger reward (including the practice choice tasks).
- The data from the computer choice task will be compared to the questionnaire responses to examine relationships between the measures. The Junior I.6 involved questions regarding impulsive behaviour. Answers from the CAMM will be compared to levels of impulsivity to determine whether there are any relationships between thinking about your thoughts and feelings and levels of impulsive choice behaviour.
- There were no correct answers. Only the main researchers in this research will see your choices and you will remain anonymous throughout. If you wish for yourself or your data to be withdrawn from the research then please let the experimenter know (see details below). Additionally, please feel free to contact the experimenter regarding any future questions you may have regarding the experiment.

Do you have any questions?

**Principle Investigator:** Jessica Bradford  
Email: [jessica.bradford@plymouth.ac.uk](mailto:jessica.bradford@plymouth.ac.uk)

Phone: 01752 233131  
Room: LB221

Appendix M

Undergraduate Study 2 (money form)

<b>P No</b>	<b>15s (a) Score</b>	<b>30s (b) Score</b>	<b>60s (c) Score</b>	<b>90s (d) Score</b>	<b>Total Monetary Reward Amount</b>
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
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## Appendix N

### PARTICIPANT CONSENT FORM (*Experiment 5*) The University of Plymouth

Principal Investigator: Jessica Bradford

#### **Research Benefits:**

- Understand impulsive behaviour better.
- Understand the relationship between impulsiveness and your ability to think about your thoughts and feelings.

#### **Task 1 (Computer Task)**

The task is to choose the money you want. Shoot spaceships to the money. Spaceships with the largest money will usually be furthest away. You will be given the amount of money you chose in the real task. This is not a test.

#### **Task 2 (Questionnaires)**

You may be asked to answer some questions about how impulsive you think you are and your ability to think about your thoughts and feelings.

I will look at your choices, your answers and possibly your behaviour in lessons to see how impulsive you were and how much you think about your thoughts and feelings.

**Risks:** None at present

**Right to withdraw:** You don't have to do this and you can stop at any time. If you don't want anyone to see what you did or you don't want to take part at any time then you can ask for this paper to be destroyed.

- 
- This research has been explained to me.
  - I understand that I don't have to do this and that I can stop at any time.
  - If I don't want anyone to see what I did then I can ask for this paper to be destroyed.
  - I understand that information about me is private and other people who are not part of this study will not be told anything about me.

If this is true then I will do the computer task and the questionnaires.

Name: .....

Age:.....

Signature: .....

Date: .....



## Appendix O

### Instructions, Brief and Debrief (Experiment 5)

#### **Brief**

Hello, my name is Jess. I work for School and The University of Plymouth. You have been invited to help me with my work. I will ask you to make some choices in a spaceship task. I am looking at your choices. You will also be asked to do 2 questionnaires. This is not a test. There are no correct answers. Tell me if you want to stop doing the task or questionnaires. No-one will know your choices. If you don't want me to use your choices in my work then tell me (or your key worker) today or in the next week. Do you have any questions?

#### **Instructions (Space Warrior X)**

- There are 2 spaceships worth money (1=1p).
- The amount of money will change.
- There is a gun at the bottom of the screen that moves.
- The gun will take longer to get to the spaceship furthest away.
- You will be asked to choose which spaceship you want to shoot.
- Tell Jess if you want to change your choice.
- When you shoot the spaceship there will be a big BANG!
- Your money will be put into the jar next to the screen.
- Please sit still. The experimenter will remain quiet during the computer task and will only answer questions about the task.

This picture is what Space Warrior looks a bit like:



### **Space Warrior Practice**

- This is the practice task with pretend money.
- There are 6 practice choices.
- You can choose any spaceship by moving the stick towards the spaceship you want.
- The gun will shoot automatically.
- The countdown clock will show that you have 60 seconds to make your choice.
- You will be told the total amount of pretend money you got at the end of the practice.

### **Space Warrior Real**

- You will play the real task now.
- It is the same as the practice, but you will have more choices.
- You will be given the money you choose.
- You will be told the total amount of money you got at the end of the real task (this will be given to a member of staff on your unit).

### **Questionnaires**

- I will now ask you some questions.
- If you don't understand please tell me
- There are no wrong answers

### **Debrief**

Thank you for helping me with my work. I will look at your choices on the task. This will tell me how impulsive your choices were. The 1<sup>st</sup> questionnaire will tell me how impulsive you are. The 2<sup>nd</sup> questionnaire will tell me how much you think about your thoughts and feelings. There were no correct answers. Only the main researchers will see your choices and your name will remain unknown. You may be asked to play it again another time.

If you have any questions or don't want me to use your choices in my work then tell your key worker (they will tell me). Thank you for helping me with my work.

## Appendix P

### Staff Rating of General Impulsivity exhibited by pupils

Please rate the degree to which you think each pupil generally exhibits impulsivity in the classroom by highlighting the appropriate number.

<b>P Initials</b>	<b>NEVER</b>			<b>SOMETIMES</b>				<b>ALWAYS</b>		
1.	1	2	3	4	5	6	7	8	9	10
2.	1	2	3	4	5	6	7	8	9	10
3.	1	2	3	4	5	6	7	8	9	10
4.	1	2	3	4	5	6	7	8	9	10
5.	1	2	3	4	5	6	7	8	9	10
6.	1	2	3	4	5	6	7	8	9	10
7.	1	2	3	4	5	6	7	8	9	10
8.	1	2	3	4	5	6	7	8	9	10
9.	1	2	3	4	5	6	7	8	9	10
10.	1	2	3	4	5	6	7	8	9	10
11.	1	2	3	4	5	6	7	8	9	10
12.	1	2	3	4	5	6	7	8	9	10
13.	1	2	3	4	5	6	7	8	9	10
14.	1	2	3	4	5	6	7	8	9	10
15.	1	2	3	4	5	6	7	8	9	10
16.	1	2	3	4	5	6	7	8	9	10
17.	1	2	3	4	5	6	7	8	9	10
18.	1	2	3	4	5	6	7	8	9	10
19.	1	2	3	4	5	6	7	8	9	10
20.	1	2	3	4	5	6	7	8	9	10
21.	1	2	3	4	5	6	7	8	9	10
22.	1	2	3	4	5	6	7	8	9	10
23.	1	2	3	4	5	6	7	8	9	10
24.	1	2	3	4	5	6	7	8	9	10
25.	1	2	3	4	5	6	7	8	9	10
26.	1	2	3	4	5	6	7	8	9	10
27.	1	2	3	4	5	6	7	8	9	10
28.	1	2	3	4	5	6	7	8	9	10

**I'd be very grateful if you could date this form and return to me at [jessica.bradford@plymouth.ac.uk](mailto:jessica.bradford@plymouth.ac.uk) or hand to me at school. Thank you ☺**

## Appendix Q

### INFORMATION SHEET (Experiment 6)

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** An Investigation into Measures of Choice Behaviour.

**Aim of research:** Does testing in school and at home influence choice behaviour? Does testing using a computer differ from tasks that do not involve a computer?

**Description of procedure:**

During the next month, you will be invited to do 4 slightly different choice tasks. You will only have to do one in a session. In each choice task you will be offered 2 different amounts of money (1 point = 1p). You will be given the money you choose in the tasks after each session. You will also be asked to answer some questionnaires. Details of each task will be given to you before each session.

If you have any questions then please ask. It is not a test. There are no right or wrong answers. Each session should take no longer than 30 minutes

## Appendix R

### PARTICIPANT CONSENT FORM 1 (CCT)

*The University of Plymouth*

#### **Measures of Choice Behaviour**

**Name of Principal Investigator:** Jessica Bradford

Research Benefits: To understand impulsive behaviour better.

#### **Task 1 (Computer Choice Task)**

The task is to choose the money you want by shooting spaceships. The larger amount will be further away so you will have to wait for the gun to reach the spaceship before the money is put in your money pot. You will be given the amount of money you chose.

#### **Task 2 (Questionnaires)**

You may be asked to answer some questions about how impulsive you think you are or your ability to think about your thoughts and feelings.

I will look at your choices, answers and behaviour in lessons to see how impulsive you are and how much you think about your thoughts and feelings.

Risks: None at present

Right to withdraw: You don't have to do this and you can stop at any time. If you don't want anyone to see what you did or you don't want to take part in this work then you can ask for this paper to be destroyed.

---

- This research has been explained to me.
- I understand that I don't have to do this and that I can stop at any time.
- If I don't want anyone to see what I did then I can ask for this paper to be destroyed.
- I understand that information about me is private and other people who are not part of this study will not be told anything about me.

If this is true then I will do the computer task and the questionnaire.

Name: .....

Age:.....

Signature: .....

Date: .....

## Appendix S

### Instructions, Brief and Debrief (Experiment 6 DAA (R) CCT)

#### **Brief**

Hello, my name is Jess. I work for School and The University of Plymouth. You have been invited to help me with my work. I will ask you to make some choices in a spaceship task. I am looking at your choices. This is not a test. There are no correct answers. Tell me if you want to stop doing the task or questionnaires. No-one will know your choices. If you don't want me to use your choices in my work then tell me (or your key worker) today or in the next week. Do you have any questions?

#### **Instructions (Space Warrior X)**

- There are 2 spaceships worth money (1=1p).
- The amount of money will change.
- There is a gun at the bottom of the screen that moves.
- The gun will take longer to get to the spaceship furthest away.
- You will be asked to choose which spaceship you want to shoot.
- Tell Jess if you want to change your choice.
- When you shoot the spaceship there will be a big BANG!
- Your money will be put into the jar next to the screen.
- Please sit still. The experimenter will remain quiet during the computer task and will only answer questions about the task.

This picture is what Space Warrior looks a bit like:



### **Space Warrior Practice**

- This is the practice task with pretend money.
- There are 6 practice choices.
- You can choose any spaceship by moving the stick towards the spaceship you want.
- The gun will shoot automatically.
- The countdown clock will show that you have 60 seconds to make your choice.
- You will be told the total amount of pretend money you got at the end of the practice.

### **Space Warrior Real**

- You will play the real task now.
- It is the same as the practice, but you will have more choices.
- When you have finished the task, the experimenter will give you the money you shot.

### **Debrief**

Thank you for helping me with my work. I will look at your choices on the task. This will tell me how impulsive your choices were. There were no correct answers. Only the main researchers will see your choices and your name will remain unknown. You may be asked to play it again another time.

If you have any questions or don't want me to use your choices in my work then tell your key worker (they can tell me). Thank you for helping me with my work.

## Appendix T

### Experiment 6

#### PARTICIPANT CONSENT FORM 2 (SCT) *The University of Plymouth*

#### **Measures of Choice Behaviour**

**Name of Principal Investigator:** Jessica Bradford

Research Benefits: To understand impulsive behaviour better.

#### **Task 1 (Sand Timer Choice Task)**

The task is to choose the amount of money you want. To get the larger amount you will have to wait for the sand timer to finish before it is put in your money pot. You will be given the amount of money you chose.

#### **Task 2 (Questionnaires)**

You may be asked to answer some questions about how impulsive you think you are or your ability to think about your thoughts and feelings.

I will look at your choices, answers, and behaviour in lessons to see how impulsive you are and how much you think about your thoughts and feelings.

Risks: None at present

Right to withdraw: You don't have to do this and you can stop at any time. If you don't want anyone to see what you did or you don't want to take part in this work then you can ask for this paper to be destroyed.

- 
- This research has been explained to me.
  - I understand that I don't have to do this and that I can stop at any time.
  - If I don't want anyone to see what I did then I can ask for this paper to be destroyed.
  - I understand that information about me is private and other people who are not part of this study will not be told anything about me.

If this is true then I will do the choice task and the questionnaire.

Name: .....

Age:.....

Signature: .....

Date: .....



## Appendix U

### Instructions, Brief and Debrief (Experiment 6 SCT)

#### **Brief**

Hello, my name is Jess. I work for school and the University of Plymouth. You have been invited to help me with my work.

I will ask you to make some choices between different amounts of money. I will be looking at the choices you make.

This is not a test. There are no correct answers. Tell me if you want to stop at any time. I will be the only person who knows the choices you make.

If you don't want me to use the choices in my work then tell me (or your key worker) today or in the next week. Do you have any questions?

#### **Instructions**

- I will ask you to choose between 2 slightly different amounts of money.
- 1 amount is available immediately, the other will be given to you when the sand timer has finished.
- For example, I may ask: "What would you like - 10p after the sand timer has finished or 5p now?"
- Your money will be put into the jar in front of you.
- Please sit still. I will be quiet when you are waiting for the sand timer to finish and will only answer questions about the task.
- You will have a practice before you start earning real money.
- You will be told the total amount of money you got at the end of the real task (this will be given to a member of staff on your unit).

#### **Debrief**

**Thank you** for helping me with my work. I will look at the choices you made. This will tell me how impulsive your choices were. There were no correct answers.

Only the main researchers will see your choices and your name will remain unknown. You may be asked to do this or a similar task another time.

If you have any questions or don't want me to use your choices in my work then tell your key worker (they will tell me). Thank you for helping me with my work.

## Appendix V

### **Jess' Research: A brief overview (Information for Staff)**

*The University of Plymouth*

#### **Research Benefits:**

- To understand impulsive behaviour better.
- To see if mindfulness skills training can help adolescents think about their thoughts and feelings and reduce impulsive behaviour.

#### **What will pupils be asked to do?**

They will be asked to attend a meeting once a week with Jess. The first 4 and last 4 meetings will involve reading newspapers/books/magazines (baseline sessions). After the first 4 meetings they will have 8 meetings (intervention sessions) to try to develop more 'mindful', present moment thinking skills. This will involve them noticing their thoughts while they listen to music, go for a walk, eat food, and hear words, then discussing what they noticed.

Pupils will also be asked to do a choice task and answer some questions week 1 (first week), week 4, week 12, and week 16 (the last week). In the choice task they can choose between different amounts of real money that will be given to them immediately or after a sand timer finishes (*money earned will be given to a member of staff, and signed off*). The questionnaires will be about how impulsive they think they are and their ability to think about their own thoughts and feelings. To cause minimal disruption to pupil's timetables, these measures will be taken during session time unless I let you know otherwise.

I will look at pupils' choices, answers, and behaviour in lessons to see how impulsive they are and how much they think about their thoughts and feelings. I will compare data collected before and after each set of sessions to determine whether the intervention had an effect on pupil's behaviour and self-reported impulsivity and mindfulness.

#### **Right to withdraw:**

Pupils don't have to do this and they can stop at any time. They will be asked to sign a consent form to agree to participate (parents/carers have given passive consent). If they tell you they wish to stop participating in this work then please let me know.

## Appendix W

### **GENERAL INFORMATION SHEET FOR PARTICIPANTS**

#### **Experiment 7 (Intervention study)**

*UNIVERSITY OF PLYMOUTH, FACULTY OF SCIENCE*

**Name of Principal Investigator:** Jessica Bradford

**Title of Research:** Measures of Choice Behaviour.

**Aims of research:**

1. Look at your choice between small rewards immediately and large rewards later.
2. Use questionnaires to look at the choices you make and your ability to think about your own thoughts and feelings.
3. See if there is a link between your choices and your thoughts.
4. If these are linked then we aim to try to improve your thinking ability.
5. Look at whether the training has improved your thinking ability and general behaviour.

**Method:** The method for what you have to do in each task will be given to you before you start each task. You will be asked to sign this form to agree to take part in each task.

**Risks:** None at present

**Benefits of this research:** Understand impulsive behaviour and your thoughts and feelings better. This could help us to make therapy and lessons more useful to you. By doing this, we hope you will be able to control your behaviour more and think more. We hope that this will help you become more independent and help you when you leave school.

**Right to withdraw:** You don't have to do this and you can stop at any time. If you don't want anyone to see what you did or you don't want to take part at any time then you can ask for this paper to be destroyed.

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If you are not happy about this research or have any questions or concerns then please tell your key worker who will be able to contact me.

## Appendix X

### **PARTICIPANT CONSENT FORM (Intervention)**

*The University of Plymouth*

**Name of Researcher:** Jessica Bradford

**Research Benefits:**

- To understand impulsive behaviour better.
- To see if mindfulness skills training can help you think about your thoughts and feelings and reduce impulsive behaviour.

**What you will be asked to do:**

You will be asked to attend a meeting once a week with Jess. The first 4 and last 4 meetings you will read newspapers/books/magazines. After the first 4 meetings you will have 8 meetings with Jess to try to develop your thinking skills. This will involve you noticing your thoughts while you listen to music, go for a walk, eat food, and hear words, then discussing what you noticed.

You will also be asked to do a choice task and answer some questions week 1 (first week), week 4, week 12, and week 16 (the last week). In the choice task you can choose between different amounts of real money that will be given to you immediately or after a sand timer finishes. The questionnaires will be about how impulsive you think you are and your ability to think about your thoughts and feelings.

I will look at your choices, answers, and behaviour in lessons to see how impulsive you are and how much you think about your thoughts and feelings.

**Risks:** None

**Right to withdraw:** You don't have to do this and you can stop at any time. If you don't want to take part in this work then please tell Jess, or your key worker, or a teacher so you can be removed from the study.

Please read and tick if you agree with each statement below

- This research has been explained to me
- I understand that I don't have to do this and that I can stop at any time
- I understand that information about me is private and other people who are not part of this study will not be told anything about me.

If this is true then I will participate in this research

Name: ..... Age: .....

Signature: ..... Date:.....

## Appendix Y

### **PARTICIPANT CONSENT FORM (PDT)**

*The University of Plymouth*

**Name of Researcher:** Jessica Bradford

#### **Research Benefits:**

- To understand impulsive behaviour better.
- To see if mindfulness skills training can help you think about your thoughts and feelings and reduce impulsive behaviour.

#### **What you will be asked to do:**

This week you will be asked to sit quietly in front of a computer screen showing a countdown timer. Each time the timer counts down to 0 you will be given 1p. You can tell Jess when you want to stop the task at anytime. When you stop, you will be given 10p in addition to the money that Jess has already given you.

I will look at all the tasks and questionnaires you have done, and behaviour in lessons to see how impulsive you are and how much you think about your thoughts and feelings at different points during our meetings.

**Risks:** None

**Right to withdraw:** You don't have to do this and you can stop at any time. If you don't want to take part in this work then please tell Jess, or your key worker, or a teacher so you can be removed from the study.

#### **Please read and tick if you agree with each statement below:**

- This research has been explained to me
- I understand that I don't have to do this and that I can stop at any time
- I understand that information about me is private and other people who are not part of this study will not be told anything about me.

If this is true then I will participate in this research

Name: ..... Age: .....

Signature: ..... Date: .....

## Appendix Z

### Experiment 7: Brief, Instructions and Debrief

#### **Brief (Baseline Sessions)**

Hi, my name is Jess and I work for school and the University of Plymouth. You have been invited to help me with my work.

Today we will look at and read a small section of a newspaper/ magazine/book – you can choose whatever interests you most from the selection provided. We can also discuss what you read.

You may be asked to make some choices between different amounts of money that will be given to you immediately or after a delay (you will be given the money you choose).

You may also be asked to answer some questions about how impulsive you think you are and your ability to think about your thoughts and feelings.

I will look at your choices, answers, and behaviour in lessons to see how impulsive you are and how much you think about your thoughts and feelings.

This is not a test – there are no correct answers. All information about you is confidential and you will remain anonymous. Please tell me if you want to stop at any time. Do you have any questions?

## **Brief (Intervention Sessions)**

Today we will be focussing on... (*name of, and small description of the mindfulness exercise*)

You may be asked to make some choices between different amounts of money that will be given to you immediately or after a delay (you will be given the money you choose).

You may also be asked to answer some questions about how impulsive you think you are and your ability to think about your thoughts and feelings.

I will look at your choices, answers, and behaviour in lessons to see how impulsive you are and how much you think about your thoughts and feelings.

This is not a test – there are no correct answers. All information about you is confidential and you will remain anonymous. Please tell me if you want to stop at any time. Do you have any questions?

## **Instructions (Sand timer Choice Task)**

- I will ask you to choose between 2 slightly different amounts of money.
- 1 amount is available immediately, the other will be given to you when the sand timer has finished.
- For example, I may ask: "What would you like - 10p after the sand timer has finished or 5p now?"
- Your money will be put into the jar in front of you.
- Please sit still. I will be quiet when you are waiting for the sand timer to finish and will only answer questions about the task.
- You will have a practice before you start earning real money.
- You will be told the total amount of money you got at the end of the real task (this will be given to a member of staff on your unit).

### **Instructions (Progressive Delay Task)**

- Each time the timer gets to 0 you will be given 1p
- When you stop you will be given 10p in addition to the 1p coins you have already received.
- Please tell Jess when you want to stop (there is no right or wrong point)
- You are required to sit quietly and still until you say stop
- Please don't touch the computer or anything in the room
- Do you have any questions?

### **Debrief (General baseline and intervention sessions)**

Thank you for helping me by attending this meeting. If you did a choice task I will look at the choices you made. If you answered questions I will look at your answers. This will tell me how impulsive you were and how much you think about your thoughts and feelings.

Only the main researchers will see your choices and answers. Your name will remain unknown. If you don't want to have these meetings with me please tell me, your key worker, or your teacher.

See you at ..... for our next meeting.

Thank you again ☺

Jess