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Effects of a gardening task on chocolate craving

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Abstract

Two concepts, craving and nature, were brought together to investigate the effects of a gardening task on chocolate craving. Participants ($n = 105$) completed a chocolate craving induction before taking part in one of three, five minute tasks (gardening, plasticine, counting). Measures of craving, mood, arousal, attention and heart rate were recorded. The gardening task was found to have beneficial effects with participants experiencing significant changes in energetic arousal ($p=.01$) and feeling good ($p<.01$); however, no significant effects were found in the other measures.

Introduction

When attempting to abstain from a substance people often report experiencing cravings. Craving is a motivational state where an urge to perform a particular behaviour is the focus of attention compelling those experiencing them to seek out and consume a desired substance (Baker, Morse & Sherman, 1986). When cravings are resisted they can be distressing, distracting (Green, Rogers & Elliman, 2000), directing attention away from other tasks (Cepeda-Benito & Tiffany, 1996), and may lead to eventual relapse. For example, Killen and Fortman (1997) found a significant relationship between 2600 former smokers and their relapse in the following 12 months. In particular, immediate post-cessation craving was found to be associated with smokers' ability to continue abstinence.

Self-reports indicate that the subjective experiences of drug-related and food-related cravings are similar, with chocolate being the most commonly craved food item (Rozin, Levine & Stoess, 1991). Biologically there are active constituents, such as methylxanthines, biogenic amines and cannaboid-like, fatty acids in chocolate which may produce similar behaviours and sensations to those of other addictive substances (Bruinsma & Taren, 1999). Moreover, there are thought to be common neural circuits involved in food and drug rewards, in particular dopaminergic pathways (Von. Deneen & Liu, 2011). Therefore, one treatment could have the capacity to provide relief for the addiction of a variety of substances.

Food craving has been associated with obesity (Von. Deneen & Liu, 2011) and with the abundance of palatable high-fat high-calorie foods in western societies it is ever increasing (Wang & Beydoun, 2007). Such cravings are defined as an intense desire to consume a specific food (Weingarten & Elston, 1990) and can trigger feelings of guilt and shame when followed by unwanted consumption (Macdiarmid & Hetherington, 1995). Although not always pathological, cravings relating to food are very common with nearly 100% of young females and 70% of young males reporting experiencing food cravings one or more times over the previous year (Pelchat, Johnson, Chan, Valdez & Ragland, 2004). However, recurrent cravings are considered important as they are believed to have an influence over snacking behaviour, adherence to restricted diets, and binge eating as well as lifetime prevalence for bulimia nervosa (Basdevant, Craplet & Guy-Grand, 1993; Gendall & Joyce, 2001; Waters, Hill & Waller, 2001; Wurtman, 1988). Clearly the development of techniques to reduce the intensity and frequency of such cravings would have an important, practical impact on health and wellbeing.

Elaborated Intrusion (EI) theory (Kavanagh, Andrade & May, 2005) posits that cravings begin with an intrusive thought triggered by associative processes, either prompted by environmental or physiological cues. For example, when walking past a bakery the smell of warm bread may trigger thoughts about it. When intrusive thoughts are pleasurable or bring relief, depending on the salience of the target and the cognitive demands at the time, elaboration usually follows. The theory proposes that elaboration is image based so one may imagine what the bread would taste like and how it would feel to consume it. It is a controlled process that involves a search for target related information; the information is then retained and manipulated in working-memory with an end result of highly elaborated thoughts about the target. The theory posits that images are linked directly to the desired substance, therefore the craver feels an initial positive sensation of reward or relief as if the substance

was actually consumed, however, the craver ultimately experiences worsened mood due to its absence. Thus, a cycle of desire is maintained whereby greater cognitive effort is directed at imagery related to the target in order to relieve the feeling of somatic and emotional deficits, or the distress, experienced due to the absence of it.

Memory is said to play a key role in craving (Kavanagh *et al.* 2005). Craving imagery is said to be stored and manipulated in the limited capacity slave systems of working memory; visual imagery is maintained in the Visuo-spatial sketchpad (VSSP) and auditory imagery in the phonological loop (PL). In particular the VSSP is important as it is essential for vivid imagery (Baddeley & Andrade, 2000) and concurrent tasks that rely on the same system will compete for priority. Hence, when experiencing a craving episode it is often difficult to concentrate on other tasks that rely on those systems (e.g. Tiggeman, Kemps & Parnell, 2010; Green *et al.*, 2000). This is advantageous for researchers attempting to manipulate craving as when given a concurrent task that competes with multi-sensory craving imagery it has been found to reduce in vividness and thus reduce craving. For example, Kemps and Tiggemann (2007) investigated the effect of modality-specific interference on chocolate craving (experiment 2). In line with EI theory the authors found that participants who completed concurrent imagery tasks experienced significant reductions in vividness of craving imagery compared to those who completed an auditory task. The study demonstrates the role of multi-sensory imagery in craving and how such imagery may be disrupted with the use of a competing task in the same modality. This effect has been replicated by May, Andrade, Panabokke and Kavanagh (2010) who showed that a concurrent imagery task reduced cigarette craving but an auditory task had no effect (experiment 1).

Other, multi-sensory tasks have also been used to load the VSSP such as modelling shapes out of plasticine, first used by Stuart, Holmes and Brewin (2006) as an aid to reduce the encoding of traumatic images. Furthermore, plasticine modelling has been found to reduce craving for cigarettes (May *et al.*, 2010). In a study by Andrade, Pears, May and Kavanagh (2012) plasticine modelling was utilised as a task to reduce chocolate craving (experiment 2). The effects of the task were compared to a simple verbal task loading the PL. Craving was induced by presenting participants with chocolate and asking questions relating to it. Participants were then asked to mould shapes out of plasticine, namely cubes and pyramids in an alternate fashion, or to count aloud in ones. The plasticine task was conducted out of sight of the participant i.e. under the table at which they sat. The task was conducted in this manner so that the participants could engage working memory by visualising an image of the shape, moment by moment, in the VSSP as they were moulding it. Craving was measured using a craving experience questionnaire (CEQ) and frequency of chocolate related thoughts was measured using thought probes throughout the 10 minute intervention. The authors found a significant reduction in craving strength, imagery, and frequency in the plasticine modelling condition compared to the control group. Furthermore, participants in the experimental condition experienced less intrusive thoughts about chocolate. The study shows the beneficial effects a simple plasticine modelling task can have on chocolate craving by interfering with craving imagery in the VSSP as well as supporting existing research on craving and modality-specific interference.

The present study aims to bring together for the first time the concept of nature, and the benefits it affords, with craving in the hope that a natural task will offer positive effects on the phenomenon in addition to reducing craving. In particular the effects active engagement with plants may have on chocolate craving in an indoor setting are of interest. It was long suspected that interacting with nature could improve cognitive functioning and well-being and such effects have now been researched and documented (Berman, Jonides & Kaplan, 2008). For example, allotments and community gardens have been utilised to provide the means for improving well-being. The benefits of engaging in these environments have been associated with factors such as increased physical activity, reduction of stress, mental fatigue and cultural integration (Armstrong, 2000). Benefits have also been reported in gardens, work spaces and institutions (Bringslimark, Hartig & Patil, 2009). Both passive and active engagement with nature has been demonstrated to increase positive affect, reduce psychophysiological arousal and improve performance on tasks that require directed attention by restoring attentional components (Bringslimark *et al.*, 2009).

Attention is an important factor in everyday life, for example problem solving relies on attentional processes. When attempting to solve a problem we have at our disposal many capabilities, stored knowledge, multiple responses, and possible actions, most of which will not be required for the problem at hand (Kaplan, 1995). The task is to select the appropriate knowledge, response and action necessary to solve the problem, inhibiting all other responses, which is traditionally the role assigned to attention (Moray, 1987). However, when the capacity to direct attention to the task at hand becomes fatigued it needs to be restored in order to enable affective problem solving. Kaplan and Kaplan's (1989) Attention Restoration Theory (ART) explains how attentional benefits may be derived from nature.

Firstly, the authors (Kaplan & Kaplan, 1989) split attention into two components; voluntary and involuntary. The involuntary component is utilised when one is fascinated by something in the environment. Attention is captured in a bottom-up fashion, requires no effort and is, hence, resistant to fatigue. In contrast the voluntary component requires top-down processing and requires effort in order to be able to direct our attention at something important. The voluntary component is inhibitory in nature as it has to hamper the tendency to be distracted by interesting things in the environment and thus can become easily fatigued. In theory, when the involuntary system is in use the voluntary system is able to rest and be restored.

Kaplan and Kaplan (1989) maintain that there are four criteria in nature that are necessary for the restoration of attention, namely fascination, a sense of being away, coherence and scope, and compatibility. When in a natural environment there are many aspects that may capture our attention such as clouds passing by, sunsets, and the leaves blowing in the breeze; such elements may elicit feelings of fascination. Attending to natural patterns is an effortless task that employs the capabilities of involuntary attention and thus allowing the voluntary component to rest allowing time for reflection which Kaplan (1993) maintains may enhance the ability to restore attention. Although a central component, fascination alone is important but not sufficient to restore attention.

While in a natural environment one may get a sense of being away from everyday routine, offering a freedom from mental activities that require support from directed attention. Although one may consider visiting the mountains, lakes or wilderness as

'getting away' the same experience can be encountered through visiting local, accessible natural environments or by simply looking at an old environment a new way (Kaplan, 1995), giving weight to the saying 'a change is as good as a rest'. The next criterion is coherence and scope. The scene has to make sense and be big enough to allow real or imagined exploration, although Kaplan (1995) argues that one can obtain this quality from miniature gardens as used by the Japanese. Finally, the environment has to be compatible with what one wishes to do and what one is trying to do. In other words the environment must not interfere with intended purposes or interests. Each criteria alone is not sufficient to restore attention and must be experienced cooperatively in order for the replenishment of the inhibitory mechanism upon which directed attentions depends. With these elements in mind it was hoped that, in the present study, a simple gardening task conducted in an indoor setting would be able to meet all of the criteria suggested by Kaplan and Kaplan (1989) and produce beneficial effects on attention.

There have been many studies that have investigated the effects of nature outdoors, for example Berman *et al.* (2008) looked into the cognitive benefits of interacting with nature (experiment 1). It was discovered that there was an improvement in attention when participants walked in nature but not when they walked in an urban area. The authors state that the finding was not mediated by mood or weather conditions and therefore demonstrates the restorative effects of nature. However, the study did involve participants walking and the exercise element may well have had an effect on the results found by the authors.

When investigating the effects of nature there remains the possibility of confounding variables such as weather conditions, effects of exercise and socialising. For example Gonzalez, Hartig, Patil, Martinsen and Kirkevold (2010) investigated the effects of therapeutic horticulture on 28 clinically depressed participants. The intervention spanned 12 weeks and involved gardening tasks such as sowing and potting plants which took place on four farms in Oslo. Reductions in depression scores and an increase in attention were found. However, it is not possible to know if the results were due to being out of doors, moderate exercise, socialising with others who were experiencing similar issues (depression) or whether the results were due to a combination of all of the factors.

Attentional benefits have been demonstrated as a result of merely viewing natural scenes in a laboratory setting (Berto, 2005), thus controlling for the variables mentioned above. Participants were given a Sustained Attention to Response Task (SART) (Robertson, Manly, Andrade, Baddeley & Yiend, 1997) in order to generate mental fatigue. The SART is computer administered paradigm and used to measure sustained attention. The task involves pressing a key each time a digit appears on screen and withholding the key press to a target digit and requires sustained attention for optimal performance. Photographs of natural or urban environments were then presented for a period of approximately six minutes and participants were again to complete the SART. It was found that there were significant differences between time one and two in reaction times and more correct responses were made for those who viewed natural scenes. Similarly, improved concentration and mood has been found in participants who viewed a natural film preceded by a scary movie (van den Berg, Koole & van der Wolpe, 2003).

Lowered blood pressure and reduced heart rate has been found in visitors at a botanical garden (Owen, 1994) and enhanced stress recovery has been demonstrated through merely viewing plants. Kim and Mattson (2002) investigated the effects of viewing red-flowering geraniums on stress recovery. Stress was induced through the use of a 10 minute film depicting the conflicts of a terminally ill man and his family. Measures of mood and physiology were taken from both males and females that experienced a 5 minute recovery period, after the induced stressor, of viewing either red-flowering geraniums, non-flowering geraniums or no plants. The authors found that among high-stress induced females there was a significant enhancement in stress recovery as well as improved positive emotions and greater attentiveness.

The literature to date show there are cognitive benefits to passive and active engagement with nature. However, studies have involved merely viewing nature or have involved participants venturing outside to walk amongst it or engage in gardening activities; the latter comprising of elements of exercise, differing weather conditions and social interaction that may have been contributing factors in restoration, factors that the present study aims to control. As of yet, it does not seem that the effects of actively engaging with nature indoors has been investigated. If such benefits do exist in indoor environments it may be of great use to those who are unable to venture outside due to poor mental or physical health allowing them to profit from the positive effects. In addition, the concept of nature and craving has not been previously researched together. It is possible that the two concepts may not necessarily fit well together. One issue may be that if attention is restored it may free up resources that could be directed at the elaboration process and therefore have an adverse effect on craving. It will be interesting to see whether reduced craving imagery is reported upon the restoration of attention.

EI theory posits craving is an important factor in providing motivation for a craver to obtain a desired substance, from which one maybe attempting to abstain, with imagery playing a key role. Therefore, the present study aims to reduce craving related imagery through the use of an indoor gardening task on chocolate craving. It is hypothesised that craving will be reduced due to the multi-sensory nature of the task, which should compete with multi-sensory craving imagery. In addition, the plasticine modelling task, as used by Andrade *et al.* (2012), will be used in order ascertain whether the gardening task is able to reduce craving to the same capacity, moreover, to find out if the gardening task may afford more benefits in comparison. A counting task will be used as a control which is not expected to have an effect on craving. As the task utilises the resources of the PL it should not interfere with imagery in the VSSP, as demonstrated by previous studies (Andrade *et al.*, 2012; Kemps & Tiggeman, 2007). The effects of nature on mood and attention are well documented, however not in the same context as the present study. Therefore, the effects of the tasks on mood, attention and heart rate will also be explored.

Method

Participants

Data collection occurred at two different times, the first sample was collected as part of research during a placement year and the second sample one year later for a final year project. The entire sample of 105 (28 Men, 77 women) comprised of psychology

undergraduates, participating as part of a module requirement for which they received points, and paid participants, who were each given £4 and a chocolate for taking part. 63 participants took part at time one and 42 took part at time two. All participants took part at the University of Plymouth and were recruited through an advertisement on a points system within the University of Plymouth intranet. Mean age was 26.1 years (age range 18- 67 years). Participants were asked to refrain from eating or drinking chocolate 24 hours before the study and not to eat or drink anything but water two hours before. All participants were tested between 1300 and 1700 hours to increase the likelihood of chocolate craving, as cravings become more frequent after midday (Hill, Weaver, & Blundell, 1991), and were asked not to take part if they were allergic to any of the ingredients in chocolate.

Design

An experimental study was conducted using a between subjects design with participants being randomly assigned to a control condition (counting backwards), a plasticine (clay modelling) condition or a gardening condition. Condition was the between subject variable and measurement of craving, mood, attention and heart rate over time was the within subjects variable.

Materials

Chocolate craving was induced in participants by use of a chocolate induction, which consisted of questions asked by the experimenter. They were shown cheap and expensive brands of chocolate that were partially unwrapped and were asked questions such as: Which bar of chocolate smells the best? Which box of chocolate looks the best? What bar of chocolate would you be tempted to sample now?

During the first data collection participants in the gardening condition were presented with a tray of mixed plants containing twelve *Violas* (approx. 11cm high x 17cm), twelve *Geraniums* (approx. 12x16cm) and eight *Lavender* plants (approx. 13x10cm) in each tray. At the second data collection participants were given *Violas* and *Lavender* as before but due to the time of year *geraniums* could not be obtained. *Delphiniums* (approx. 13x12cm) were used as a replacement due to the similarity in the size of foliage. Each tray of plants had a label with a picture indicating how the plant would look in full bloom. At the time of both data collections the *Violas* were already in bloom with flowers of various colours (purple, white and yellow). Stones were used to cover the bases of 17cm pots; a small trowel to fill the pots with compost and a watering can to water the plants once they had been re-potted. Heart rate was monitored with participants in an upright seated position (model PL-600, Cateye). Plasticine (NewplastTM, Newclay Products Limited, Newton Abbot, UK) was used in the second experimental condition.

Measures

Participant's desire for chocolate prior to the task (time 1) was measured using the craving experience questionnaire (CEQ_{now}) which is a restructured form of the alcohol craving experience questionnaire created by Statham, Connor, Kavanagh, Feeney, Young, May and Andrade (2011). Participants were asked to consider how they felt about chocolate at that precise moment, asking questions such as: How strongly do you want it? How vividly are you picturing it? How hard are you trying not to think about chocolate? The answers were recorded on a 100mm analogue scale, where 0 indicates "not at all" and 100mm indicates "extremely". Desire for chocolate during the task (time 2) was measured using the CEQ_{thenS} and CEQ_{thenF}. Both

questionnaires are similar to the CEQ_{now} but asks questions related to the strength (CEQ_{thenS}) and frequency (CEQ_{thenf}) of craving experiences during the task. Participants were asked to think about the time they most wanted chocolate during the task, questions included: How much did you need it? How vividly did you imagine the smell? How intrusive were the thoughts. Frequency questions included: During the task, how often did you have an urge to have it? Imagine its taste? Did you have a strong urge to eat chocolate?

To assess mood the Activation Deactivation Adjective Check List (ADACL) (Thayer, 1989) was utilised. ADACL is a list of 20 adjectives, each describing feelings or mood (e.g. active, calm, fearful, anxious). The scale is broken down into two subscales: energetic and tense arousal. Arousal is said to be the basic element of mood and behaviour (Thayer, 1989), therefore, energetic arousal is associated with feelings such as vigour and liveliness while tense arousal is associated with feelings of tension and anxiety. Participants were asked to rate each adjective on scale of 0-3 (0= definitely do not feel; 1= cannot decide; 2= feel slightly; 3= definitely feel), choosing the answer that best corresponded to their mood at that time.

Affective valence and activation were measured using the Feelings Scale (FS) (Hardy & Rejeski, 1989) and the Felt Arousal Scale (FAS) (Svebak & Murgatroyd, 1985). The FS is an 11 point bipolar scale that allows participants to rate core emotions: feelings of pleasure and displeasure, from +5 (very good) through 0 (neutral) to -5 (very bad). Participants rated how aroused (worked up) they were using the FAS. They were given examples of high arousal that might be felt, such as excitement, anxiety and anger in addition to examples of low arousal such as relaxation, boredom and calmness, these were rated on a scale from 0= low arousal to 6= high arousal.

Attention was assessed using Sustained Attention to Response Task (SART) (Robertson, Manly, Andrade, Baddeley & Yiend, 1997). The task lasts for approximately five minutes and involves responding to visually presented digits with a key press and withholding key presses to rare targets (the number three). Each of the 225 digits (displayed for 250-msec) was followed by a mask (displayed for 900-msec) that consists of a ring with a diagonal cross going through it. Both digits and mask were presented in white on a black background in the centre of a computer screen. The target digit was presented 25 times and distributed throughout the 225 trials in a pre-fixed quasi-random manner. Digits were presented in five different fonts (48, 72, 94, 100 and 120 point) in order to prevent reliance on a search template to identify peripheral features of the no-response target, enhancing demands for processing the numerical value. Participants were given a practice trial to familiarise themselves with the task.

Errors made can be predicted by fluctuations in performance, they are not considered to be isolated events but a consequence of failing to maintain an optimum approach to the task over time. As the SART stimuli are presented in a predictable, rhythmic fashion responses to non-targets can become automatic and attentionally undemanding. Maintenance of attention can counter this effect and correct withhold to the target digit is possible. Absence of attention can be detected in the speeding responses to stimuli which suggests responses are made in anticipation rather than as a result of an evaluation of the stimulus and appropriate response. All computer based tasks were completed on a 20 inch Samsung.

Procedure

Participants were emailed before the study asking them to refrain from eating chocolate 24 hours before the study and not to eat or drink anything but water 2 hours before. Participants were tested individually. Upon arrival, they were asked to sit and relax, in order to stabilise heart rate, while reading the brief and signing the consent form. An ear clip was then attached to one ear, allowing heart rate to be monitored. Heart rate was recorded three times during the study, once before the task, during (2.5 minutes into the task) and after the task. Next, with the aim to induce chocolate craving, thus loading the VSSP and utilising attentional resources, participants were taken through the chocolate induction. Upon completion, participants were required to fill in the CEQ_{Now}, ADACL, FS and FAS on a computer. After each presentation of the ADACL the experimenter recorded heart rate, except during the task when there was no presentation of the ADACL.

Once the initial questionnaires had been completed on the computer participants took part in one of three 5 minute tasks: Gardening, plasticine modelling or counting backwards by ones, to which they were randomly assigned. All tasks were conducted whilst in a seated position. In the gardening condition, participants were presented with a tray of mixed plants and were given instructions on how to complete the task. The aim was to pick three plants to re-plant into another larger pot. Participants were given five minutes to complete the task which included covering the base of the plant pot with stones for drainage; half filling the pot with compost; arranging the plants of their choice in the pot; adding more compost to secure the plants, and finally, participants were given instructions to water them. If the task was completed in less than five minutes they were asked to choose another plant to re-pot into another pot. All participants were told that there was no right or wrong way to complete the task and were given enough time to complete it.

The plasticine task involved participants making pyramids and cubes in alternate fashion and placing them into corresponding positions on the table at which they sat (pyramids on the left, cubes on the right). Participants were to use both hands, keeping them out of sight while making the shapes. They were asked to make the shapes as quickly and as accurately as possible and to facilitate task compliance they were told that the shapes would be rated by the experimenter. A practice trial was given to allow the participants to become familiar with the task. The counting condition involved the participants counting aloud, backwards by ones from 958 at a rate of approximately one number per second, demonstrated by the experimenter. Half way through the tasks in each condition (2.5 minutes) heart rate was recorded by the experimenter.

Once the task was completed participants were asked to fill in the CEQ_{thenS}, CEQ_{thenf}, ADACL, after which the final heart rate measure was taken, FS, and FAS. On completion of the questionnaires, participants were presented with the SART. Finally, in order to control for demand characteristics, they were asked what they thought was the purpose of the study, offered a chocolate as a thank you and were given a debrief. The testing procedure lasted approximately 30 minutes.

Results

Craving

The CEQ_{now} had high Cronbach's alpha ratings of .93. The strength, imagery and intrusiveness sub-scales were also highly reliable with Cronbach's alpha ratings of between .87 and .95, excluding the intrusiveness subscale in the CEQ_{now} which had a rating of .73. The reliability scores were similar to those found by Andrade *et al.* (2012). Participants with a mean score of three or above in the strength sub-scale of the CEQ_{now} were selected for analysis ($n=82$) the remainder ($n=23$) were removed from the data file as they were not considered to have sufficient chocolate cravings. A one way analysis of variance (ANOVA) showed that although there was a significant difference found between conditions before the intervention for the mean craving scores $f(2,79) = 3.17, p = .05$, there were no significant differences between the sub-scales of craving strength $f(2,79) = 2.13, p = .13$, imagery $f(2,79) = 1.54, p = .22$ or intrusiveness $f(2,79) = 2.54, p = .09$.

The overall mean craving scores from the CEQ were 5.43 ($n=82, SD=1.48$) pre-intervention and 2.67 ($n=82, SD=2.39$) post-intervention, indicating that over time craving scores decreased. Table 1 shows the difference in mean scores (time 2 scores were deducted from time 1 scores) for the CEQ sub-scales for each condition. The Table shows that participants in the garden condition experienced the greatest difference between means at time one and time two in each of the craving sub-scales compared to the plasticine and counting conditions. The greatest difference in means between groups was found in the intrusiveness sub-scale.

Table 1: CEQ sub-scale difference scores for the means of each condition.

	Garden	Plasticine	Counting
Strength	3.42	2.58	2.26
Imagery	4.25	2.71	3.31
Intrusiveness	2.68	1.09	1.37
Craving Overall	3.58	2.26	2.48

A 2 (time: CEQ_{now}, CEQ_{thenS}) x 3 (condition: garden, plasticine, counting) mixed design ANOVA was conducted on the craving data to compare the condition means for each sub-scale, with time as the within factor and condition the between factor. Sphericity was not assumed; therefore the Greenhouse-Geisser correction was used. The analysis showed main effects of time for strength of craving $f(1,79) = 84.11, p < .01, \eta_p^2 = .52$, imagery $f(1,79) = 103.13, p < .01, \eta_p^2 = .57$, intrusiveness $f(1,79) = 36.03, p < .01, \eta_p^2 = .32$, and craving overall $f(1,79) = 96.24, p < .01, \eta_p^2 = .55$. Homogeneity of variance was assumed with no main effects of condition on strength $f(2,79) = .31, p = .71, \eta_p^2 = .01$, imagery $f(2,79) = .58, p = .57, \eta_p^2 = .01$, intrusiveness $f(2,79) = 1.1, p = .34, \eta_p^2 = .03$ or overall craving scores $f(2,79) = .79, p = .46, \eta_p^2 = .02$ found. Similarly, the analysis showed no significant interaction between time and

condition for strength $f(2,79) = 1.32, p = .27, \eta_p^2 = .03$, imagery $f(2,79) = 1.73, p = .18, \eta_p^2 = .04$, overall craving $f(2,79) = 2.06, p = .14, \eta_p^2 = .05$, with intrusiveness being marginally non-significant $f(2,79) = 2.93, p = .06, \eta_p^2 = .07$.

The sub-scale means of frequency for each condition were similar suggesting there were no differences between groups. The overall craving frequency mean was 2.38 (SD = 2.36, $n = 82$). A one way ANOVA on the CEQ_{thenf} showed there were no significant differences between the conditions for strength $f(2,79) = .10, p = .91$, imagery $f(2,79) = 1.05, p = .36$, intrusiveness $f(2,79) = .62, p = .54$, or craving overall $f(2,79) = .52, p = .60$.

Mood

The two sub-scales of tension and energetic arousal contain contrasting terms of arousal, for instance, nervy and placid; active and sleepy. In order to analyse the data the contrasting items were reversed, for example a score of 0 for sleepy became a 4, a score of 1 became a 3 and so on. Once contrasting items were reversed, both sub-scales depicted complementary examples of arousal with the items sleepy, tired and drowsy being reversed in the energetic sub-scale. The items placid, calm, at rest, still and quiet were reversed in the tension sub-scale. The ADACL was found to be highly reliable with a Cronbach's alpha rating of .83, as was the energetic subscale with a rating of .9. The tense subscale had a slightly lower Cronbach's alpha rating of .74.

Table 2: Means and standard deviations (in parenthesis) for tense and energetic arousal at time one and time two ($n = 82$)

	Time 1	Time 2
Tense Arousal	13.56 (4.31)	14.99 (4.91)
Energetic Arousal	16.71 (6.70)	18.52 (6.36)

Table 2 shows how the means for tense and energetic arousal increased over time. A 2 (time 1, time 2) x 3 (condition: garden, plasticine, counting) mixed design analysis of variance (ANOVA) was conducted with time as the within factor and condition as the between. As sphericity could not be assumed the Greenhouse-Geisser correction was used. The analysis showed evidence for differences between the means over time for tense arousal $f(1,79) = 5.02, p = .03, \eta_p^2 = .06$ and energetic arousal $f(1,79) = 8.09, p = .01, \eta_p^2 = .09$. Homogeneity of variances was assumed and no main effects for condition were found for either tense $f(2,79) = .13, p = .88, \eta_p^2 = .01$ or energetic arousal $f(2,79) = .35, p = .71, \eta_p^2 = .01$. A significant interaction was found between time and condition for energetic arousal $f(2,79) = 4.61, p = .01, \eta_p^2 = .12$ indicating that increases in energy were dependent on condition. There was no significant interaction for tense arousal $f(2,79) = .72, p = .5, \eta_p^2 = .02$.

Post hoc comparison t-tests were performed in order to determine which conditions underwent differences in energetic arousal. Tests show that participants in the gardening condition felt a significant difference in energetic arousal $t(26) = -4.81, p < .01, r = .71$. No differences in energy levels were found for participants in the plasticine $t(26) = -.84, p < .41, r = .63$ or counting conditions $t(26) = .03, p < .98, r = .43$.

Analysis of the FS and FAS consisted of 2 (time) x 3 (condition) mixed ANOVAs. Sphericity on the scales was not assumed; therefore Greenhouse-Geisser corrections were used. Homogeneity of variance was assumed for both scales.

The mean scores for the FS were similar at time one ($M = 2.5$, $SD = 1.59$, $n = 82$) and at time two ($M = 2.54$, $SD = 1.52$, $n = 82$). Analysis showed no significant differences over time $f(1,79) = .1$, $p = .75$, $\eta_p^2 < .01$, no significant difference between conditions $f(2,79) = .12$, $p = .88$, $\eta_p^2 < .01$, but did show a significant interaction between time and condition $f(2,79) = 5.88$, $p < .01$, $\eta_p^2 = .13$, indicating that change in feeling was dependent on condition. Post hoc comparison t-tests were conducted to determine in which conditions the differences in feeling could be found. Analysis showed that participants in the garden condition felt better after the intervention $t(26) = -3.12$, $p < .01$, $r = .78$ in comparison to the plasticine $t(26) = .88$, $p < .39$, $r = .68$ and counting $t(26) = 1.56$, $p < .13$, $r = .71$ conditions.

Mean scores for FAS at time one were 2.93 ($SD = 1.21$, $n = 82$) and at time two 3.20 ($SD = 1.16$, $n = 82$). Analysis showed there were no significant differences over time $f(1,79) = .32$, $p < .08$, $\eta_p^2 = .04$, between conditions $f(2,79) = .66$, $p < .52$, $\eta_p^2 = .02$, and no significant interactions were found $f(2,79) = .42$, $p < .66$, $\eta_p^2 = .01$.

Correlations

In order to investigate relationships between the significant changes found in energetic arousal and feeling a bivariate correlation was conducted. The analysis shows that changes in energetic arousal were significantly related with changes in feeling, $r = .34$, p (one tailed) $< .01$ which indicates that change in arousal shares 11.7% of the variability with changes in feeling leaving 88.3% of the variation unexplained.

Attention

In order to analyse the SART data the means and standard deviations (SD) were calculated for all reaction times (RT). Due to the variation in RTs it was considered best to limit RTs to those within two SDs of the mean with an average of 4.2 per cent being cut from the data file. Of particular interest was participants' response to the digit 3. Therefore, mean RTs were calculated for the four responses before correct withhold to 3, four after the correct withhold to 3, four before incorrect response to 3, and four after incorrect response to 3. This was conducted in order to see whether participants sped up or slowed down before and after each correct and incorrect response.

The mean number of responses for all groups differed only slightly. For the correct withhold to 3, $M = 15.24$, $SD = 5.10$, incorrect withhold to 3, $M = 9.76$, $SD = 5.10$, correct response to all other numbers, $M = 196.85$, $SD = 5.40$ and incorrect response to all other numbers, $M = 3.15$, $SD = 5.40$. The results from a one way ANOVA showed there were no significant differences between groups for correct withhold to 3, $f(2,79) = .02$, $p = .98$, incorrect withhold to 3, $f(2,79) = .02$, $p = .98$, correct response to all other numbers, $f(2,79) = .66$, $p = .52$, and incorrect response to all other numbers, $f(2,79) = .66$, $p = .52$.

Table 3: Mean reaction times (in milliseconds) and standard deviations for correct and incorrect responses before and after the target number 3.

	Mean	Standard Deviation
Mean RT four before correct withhold to 3	326.75	62.95
Mean RT four after correct withhold to 3	276.76	69.54
Mean RT four before incorrect withhold to 3	284.49	49.82
Mean RT four after incorrect withhold to 3	286.57	81.57

The mean RTs presented in table 3 shows that the participants responded to the task in the way that Robertson *et al.* (1997) would predict with participants responding more quickly before and slowing down after making an error. A one way ANOVA showed there were no significant differences between groups for the mean RT for four before or after the correct withhold to 3 $f(2,79) = 2.58, p = .08$ and $f(2,79) = 1.26, p = .29$ respectively or the mean RT for four before and after the incorrect withhold to 3 $f(2,79) = 1.97, p = .15$ and $f(2,79) = 1.87, p = .16$ respectively.

Heart Rate

The mean heart rate for each group indicates there were differences over the three time periods. The mean at time one was 76.32 (SD =12.79 $n =82$), at time two it increased to 84.16 (SD = 12.56, $n =82$) and at time three, once the task had been completed, the means returned to baseline measures 76.56 (SD = 11.71, $n =82$). A 3 (time) x 3 (condition) mixed ANOVA, with time as the within factor and condition as the between factor showed there were significant effects of time $f(1.58,124.85) = 54.93, p < .01, \eta_p^2 = .41$. There was no significant effect of condition $f(2,79) = .21, p < .82, \eta_p^2 = .01$ or interaction between time and condition $f(3.16,124.85) = .72, p < .55, \eta_p^2 = .02$.

Discussion

An indoor gardening task was found to improve mood and energetic arousal. For example, participants may have felt more vigorous, full of vitality and less tired, in addition to experiencing higher levels of positive affect in relation to those in the other conditions. The findings are consistent with previous studies that have investigated the effects of nature on mood (Gonzalez *et al.*, 2010; Kim & Mattson, 2002; van den Berg, 2003). The present study has extended these findings by finding improvements of mood due to active engagement with plants in an indoor environment.

The improvements in affective valence and energetic arousal were positively correlated, indicating a relationship between the two. The direction is unknown, therefore, it is not known if feeling good is the cause of the increase in energy or if the opposite relationship exists. Over time it was found participants in all groups experienced an increase in energetic and tense arousal. The tension sub-scale

included items such as tense, nervy and fearful and it is possible that these effects may have been partly due to the laboratory setting. No significant results were found for the Felt Arousal scale and, therefore, will not be mentioned here on in.

Although there were no significant differences found between conditions by analysing the CEQ data, the sub-scale of intrusiveness was only marginally non-significant ($p=.06$). This suggests there was a small difference between groups for the amount of intrusive craving imagery experienced during the intervention. However, the intrusiveness sub-scale only contains three items and may be considered less reliable than the strength and imagery sub-scales. EI theory posits that cravings are triggered by intrusive thoughts followed by the image based elaboration process. Therefore, it is possible that participants would have experienced a reduction in intrusiveness prior to a reduction in imagery vividness, strength of craving and craving overall.

The hypothesis that gardening and plasticine tasks would sufficiently interfere with craving imagery in the VSSP and thus significantly reduce craving was not supported by the present study. However, the craving sub-scale means indicate that strength of craving, imagery, intrusiveness and overall craving scores were reduced in the direction expected for those in the gardening condition. This finding is congruent with EI theory and the hypothesis of the present paper. The means show that the garden condition was consistent in having the largest difference scores between time one and time two for each of the sub-scales and overall craving which suggests the beginning of an interfering effect on craving imagery.

It was surprising to find that those in the counting condition had the next largest difference scores in all but the strength sub-scale. It was thought that the plasticine task would have had a larger effect as it employs the resources of the VSSP and has previously been found to reduce craving for chocolate (Andrade *et al.*, 2012) and cigarettes (May *et al.*, 2010). However, in previous studies using the task participants moulded plasticine for 10 (Andrade *et al.*, 2012) and 12.5 (Stuart, *et al.*, 2006) minutes, whereas in the present study the task had a 5 minute duration. Therefore, task duration may explain the lack of craving reduction found in the present study for the plasticine condition. As expected the counting task did not significantly reduce craving, which is in support of previous work looking into the selective impact of craving (May, Andrade, Panabokke and Kavanagh, 2010; Kemps & Tiggeman, 2007), although the means suggest that the task effects were stronger than those of the plasticine condition.

The counting task may have been more effective at reducing craving than the plasticine task due to the difficulty many of the participants experienced whilst doing it. Numerous mistakes were made by the participants and it was clear that they had to focus intently on completing the task. If task difficulty was the cause of the effect then there is a possibility that visual imagery was utilised by the participants in order to successfully complete the task as it would entail the resources of the VSSP and have an interfering effect on craving imagery. For some the effect may have been due to the ease of the task with participants experiencing boredom and mind wandering and as a consequence losing their counting position or counting in an ascending rather than descending fashion. Participants may then have had to put more effort into paying attention to the task which could have had an effect on craving. Counting, although used as a control task, seems to have a larger effect on

reducing craving in relation to a plasticine moulding task. Future research looking into the effects of counting on craving may be beneficial as it would be a cost effective task that could be used by cravers in any setting.

The present study was not able to replicate the reduced frequency of craving related thoughts or images found by Andrade *et al.* (2012) as no differences between conditions were found. However, there was an interesting pattern in the frequency means for each sub-scale (found in Appendices N-Q). Participants in the counting condition experienced less frequent images, intrusive thoughts and craving overall in relation to the garden and plasticine conditions. The garden task was found to be more effective at reducing the frequency of strength of urges with the plasticine task being the least effective of all conditions. Future research might do well to investigate the effects of counting tasks on craving as it has previously been found to reduce chocolate craving (Andrade *et al.*, 2012). Andrade *et al.* (2012) used counting backwards in 3s (experiment 1a) and found that this task reduced craving due to the employment of visuospatial short-term memory to complete the task. Counting backwards in 3s was almost as effective as a plasticine modelling task. The authors state that the counting task had larger general resource load than the plasticine task. Subsequently, task difficulty was reduced by asking participants to count upwards in 1s (experiment 2). The task sufficiently loaded the PL without requiring the use of visuospatial short-term memory and, hence, no longer affected craving. Counting backwards in ones may require a similar amount of resources as counting backwards in 3s which would partly explain why it was more effective at reducing craving than the plasticine task.

It is possible that the improvements found in mood and energetic arousal suggests the beginning of an effect in the reduction of craving. Whilst in a craving state, mood is lowered due to the effects of the elaboration process; the initial feeling of reward or relief obtained by imagining the consumption of a substance is then followed by a feeling of worsened mood due to the absence of it. Moreover, previous research (Adam & Epel, 2007) has demonstrated increased craving due to negative mood. The improvements found in the current study may have been in response to fewer craving images which was reduced over time for all conditions. Feeling fatigued and in need of an energy boost is associated with the consumption of high calorie foods (Thayer, 2001). Taylor and Oliver (2009) investigated the effects of exercise on chocolate craving and found that chocolate craving was associated with changes in activation. Participants with lower activation levels reported stronger urges to consume chocolate and those with higher activation had weaker urges. It would be interesting for future researchers to investigate ways of raising energy levels in chocolate cravers, using natural tasks and controlling for exercise, to see if the need to eat chocolate is diminished, moreover, to investigate the effect of a garden task on negative mood.

All of the tasks had a significant effect on heart rate over time. Participants began with a baseline heart rate, which rose significantly during the tasks. At post-intervention heart rate returned to baseline measures. There were no predictions made about heart rate, it was a purely exploratory measure. Although the findings of the present study are not congruent with those of Owen (1994) who found reductions in heart rate in visitors of a botanical garden, the rise in heart rate during the task fits with Thayer's (1989) account of arousal as a basic element of mood and behaviour.

He suggests that we move from quiescence to activity and back to quiescence again throughout each day. Exerting energy and feeling good corresponds to energetic arousal, exerting energy and feeling threatened reflects tense arousal. The garden task is not generally considered unpleasant and taking this into consideration with the reported increases in positive affect increases in energetic arousal would be consistent with his theory.

Analysis of attention data involved testing if there were any differences between conditions in response to the target digit (3), it is to this digit which a key press must be withheld and thus takes powers of concentration for optimal performance. No significant differences were found, either in correct or incorrect responses to 3. Further analysis looked at the responses to all other numbers which offered no significant differences between the groups. Moreover, no significant differences were found in relation to RT means for four responses before and after correct and incorrect responses to the target digit. However, upon closer inspection it could be seen that in all conditions participants RTs were slower before a correct withhold to 3, suggesting they were paying attention to the task, and following a correct response they tended to speed up a little, maybe due to gaining confidence in their ability to complete the task successfully. However, after an error response only those in the counting condition adjusted their RTs to a slower pace with those in the garden and plasticine conditions speeding up. This suggests that even though condition did not have an overall effect on performance it may have influenced sensitivity to responding after an error. That fact that the counting task may have provided such a benefit is not what one would expect considering previous research into the cognitive effects of nature.

In a review by Bringslimark *et al.* (2009) it is stated that the time of exposure to plants in previous experiments ranged from 10 minutes to one year, with the exception of one study where effects were found after 5 minutes of exposure (Kim & Mattson, 2002). It is argued that some of the studies may not have exposed participants to the plants for long enough (e.g. Lohr & Pearson-Mims, 2000) and some for too long with participants habituating to the presence of the plants (Shoemaker, Randall, Relf & Geller, 1992) therefore attenuating the effects. Kim and Mattson (2002) found improved attentiveness from viewing red-flowering geraniums but on closer inspection attentiveness was reduced in all conditions (flowering, non-flowering, no plants) and in the flowering condition the least. It is possible that exposure time was not long enough for an increase in attentiveness. The time exposure for the present study was 5 minutes which may not have been long enough a duration for a significant effect on attention to be found.

Interestingly, no significant differences in stress recovery responses were found in mild-stress induced female participants in the Kim and Mattson (2002) study. Ulrich (1986) states that views of nature has positive effects on emotional and physiological states but that the effects maybe greatest for those experiencing stress and anxiety. Therefore, the mildly stressed females may not have been sufficiently stressed to experience the effects of viewing the geraniums. As the effects of nature may be greatest for those experiencing stress or anxiety (Ulrich, 1986) the craving induction used in the present study may not have sufficiently caused either. It was thought that by loading the VSSP with craving imagery participants would be adequately stressed enabling the measurement for any improvements of attention. Even though the

induction was sufficient to induce craving it may not have been a robust enough process to adequately cause the optimum amount of stress needed for a natural task to have a beneficial effect on attention.

One possible limitation of the present study was the reliance on retrospective answers in response to the CEQ_{then}s and CEQ_{then}f. The questionnaires rely on participants' accounts of their craving experiences during the task which may be unreliable. However, on reflection it was thought best to offer the retrospective questionnaires rather than the CEQ_{now}. The CEQ_{now} asks participants how much they are thinking about chocolate at that particular moment in time and may have then triggered thoughts of wanting to consume it which in turn would raise their craving scores. Furthermore, it is also possible that some of the participants may have misinterpreted the questions in CEQ_{then}s and CEQ_{then}f and based their responses on how they were feeling about chocolate right at that particular moment instead how they felt during the task. If misinterpretation of questions occurred this may have had an effect on the overall craving ratings post- intervention.

In conclusion active engagement with nature in an indoor setting has been found to improve mood and increase energetic arousal. Moreover, it has been found to reduce chocolate craving, although not significantly. The findings may signify the beginning of an effect on chocolate craving reduction. Therefore future research looking into optimal exposure time necessary for further reductions would be beneficial to people with eating disorders.

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