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Hunger-related intrusive thoughts reflect increased accessibility of food items

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Abstract

The Elaborated Intrusion model (Kavanagh, Andrade & May, 2005) argues that a craving episode begins with a desire-related intrusive thought. This study tests the assumption that such intrusive thoughts, during hunger, reflect an increase in accessibility of food-related information in memory. Fifty-six undergraduates were randomly assigned to hungry or satiated conditions. Hunger was manipulated by asking the 'hungry' group to abstain from eating breakfast and snacks prior to testing before lunch, while the 'satiated' group was asked to eat normally and attend testing after lunch. Participants completed a lexical decision task containing food-related and neutral words, an intrusive thoughts questionnaire and a hunger questionnaire. Priming for food-related items relative to neutral on the lexical decision task was higher for hungry participants than satiated participants. Priming correlated strongly with frequency of food-related intrusive thoughts during the task. We conclude that desire-related lexical decision priming could provide a useful objective correlate of proneness to desire-related intrusions.

Introduction

Intrusive thoughts are subjectively felt to occur spontaneously, without effort or origin and are an ordinary experience for the majority of the population, concerning work or food, for example. However, intrusive thoughts are characteristic of several clinical disorders, for example Generalised Anxiety Disorder, Obsessive Compulsive Disorder and Post-Traumatic Stress Disorder (Purdon, 1999; Langlois, Freeston, Ladouceur, 2000a,b; Green, 2003; Watkins, 2004). They also take the form of intrusive memories in post-traumatic stress disorder and depression (Reynolds and Brewin, 1999) and can be experienced by non-clinical populations (Brewin, Christodoulides and Hutchison, 1996; Langlois, Freeston and Ladouceur, 2000a, 2000b; Bywaters, Andrade and Turpin, 2004). Recently, the Elaborated Intrusion theory (EI theory) has given them a key role in addiction and motivated behaviour more generally (Kavanagh, Andrade & May, 2005).

The EI theory of desire views intrusive thoughts as the gateway to episodes of craving. Eliciting factors, such as environmental or internal target-related cues, increase the accessibility of target-related information by activating semantic or episodic memory representations; this increases the probability of a target-related intrusive thought. If the thought is salient or concurrent cognitive activity has low priority then the intrusive thought can trigger elaborative processes. This elaboration involves a controlled cognitive search for target-related information and retention of this information in working memory, resulting in highly elaborated cognitions concerning the target, usually in the form of mental imagery: people imagine the target and its consumption, for example, unwrapping and tasting a chocolate bar, or taking a drag on a cigarette. This imagery simulates the actual experience and so is momentarily pleasurable, but in the longer-term it exacerbates awareness of deficit and lowers mood, causing the aversive sensation of craving when the desire is unfulfilled. These processes serve to maintain the goal of target acquisition.

There is evidence to support intrusive thoughts and elaboration in craving for a range of substances. A questionnaire study by May, Andrade, Panabokke and Kavanagh (2004) found that participants rated “I suddenly thought about it” joint top with “I felt hungry/thirsty/tired/physical discomfort” from a list of potential triggers of craving. The role of elaboration has been supported by experimental disruption of the working memory processes that support mental imagery (Kemps, Tiggemann, Woods and Soekov, 2004; Panabokke, 2004). The role of intrusive thoughts in craving is consistent with the finding that thought suppression, a technique known to increase intrusions (Wegner, Schneider, Carter and White, 1987; Lavy & van den Hout, 1990; Clark, Ball & Pape, 1991) exacerbates craving for cigarettes (Salkovskis & Reynolds, 1994; Toll, Sobell, Wagner and Sobell, 2001).

Thus the EI theory argues that triggers of craving increase the accessibility of craving-related information, which in turn increases the probability of a craving-related intrusion. This increased accessibility is distinguished from desire itself, along with other associated cognitions, physiological deficits, or environmental cues, as an antecedent to desire. The occurrence of these events may increase the probability of desire, but they do not represent the phenomenon itself. Therefore a state of increased accessibility of craving-related information represents a state in which craving might occur.

Evidence of increased accessibility in craving situations comes from a study by Jarvik, Gross, Rosenblatt and Stein (1995), who found that overnight abstinence from smoking, by a group of heavy smokers, enhanced lexical processing of smoking-related words. An unpublished study by Phillips, Kavanagh, May and Andrade (2004) further supports this; when asked to generate words about relaxation, deprived or quit smokers gave more smoking-related words than either non-smokers or non-deprived smokers.

The EI theory also argues that motivational behaviours, such as hunger and thirst, are not merely physiological states but have analogous cognitive processes to desire, despite not being craving for a particular substance (i.e. a particular food or drink). Whilst hunger and

thirst are not examples of craving per se, they are states within which a craving episode can occur, i.e. the physiological deficit can act as an antecedent to desire and we can expect an increase in accessibility of hunger-related or thirst-related information in memory. It is possible to measure these pre-cursors to craving.

A recent study by Aarts, Dijksterhuis & De Vries (2001) is consistent with these claims from the EI theory. They demonstrated that accessibility of drink-related items increases with thirst, using a lexical decision task as a measure of cognitive availability: faster response latencies to specific items indicate enhanced availability (e.g., Meyer & Schvaneveldt, 1971). Participants were randomly assigned to consume three salty sweets (thirsty condition), to draw three figures, or to consume three non-salty sweets (non-thirst conditions). They completed a lexical decision task consisting of nonsense words, neutral words and drinking-related words. Thirsty participants responded faster to drinking-related items than neutral items, and subsequently recalled more drink-related items compared to no-thirst participants. The present study aims to link these two areas of investigation by looking at the relationship between the frequency of intrusive thoughts about a desired target and the increased availability of desire-related material. Rather than testing a state of craving as such, this study aims to explore the pre-cursors of craving in a state in which craving might occur. It does so by replicating Aarts et al.'s (2001) task with food-related words, with a manipulation of hunger brought about by asking participants to refrain from eating breakfast and morning snacks or to eat as normal, including lunch, prior to testing. To minimise memory and other biases, participants reported the number of intrusions experienced over a very brief period, namely the duration of the lexical decision task.

Method

Materials

For the lexical decision task, word lists are required which contain an equal number of words and non-words. In this study non-words were created using a method taken from Lacruz and Folk (2004). This involved splitting existing words to form list of heads and bodies, for example, 'brake' was broken into 'br' and 'ake'; these were then exchanged quasi-randomly to create non-words (for example, the head of brake and the body of meal were put together to form 'breal'). To avoid words and their component fragments appearing in the same list, we devised two parallel sets of lists where the words from set A were paired with the non-words from set B and vice versa. We devised explicit practice lists of 3 neutral and 3 non-words, (mean length 7.33 letters), buffered trials lists of 5 neutral and 5 non-words (mean length 6 letters), and two experimental lists of 8 food, 16 neutral and 24 non-words (see Appendix; mean length list A = 5.42 letters, list B = 5.58 letters). The 40 neutral words used in the two sets of lists (including practice, buffered and experimental lists) were taken from Mogg, Bradley, Hyare and Lee (1998), and were all transport related nouns. A pilot experiment guided the selection of food-related words. Eight hungry participants were asked to write down the first twenty words that they could think of. A set of 16 food words was then constructed based on the most frequently occurring words and word types, with a mixture of eating-related words (e.g., hungry, lunch, stomach) and food words (e.g., food, meal, cheese, chocolate). Food words anticipated to be unacceptable to some people (e.g., meat words) were avoided. These were arbitrarily divided between word-lists A and B so as to maintain equality of mean word length within the lists. The neutral and food words did not differ significantly in frequency of occurrence in the 100 million word British National Corpus (2001).

The Lexical Decision task was presented on a 233MHz iMac G3 with 256Mb RAM, running MacOS 8.6, using Pyscope software (Cohen, MacWhinney, Flatt and Provost, 1993) to run the experiment. Each item (words and non-words) was presented in the centre of the computer

screen in Chicago font, 35-point font size. Responses were collected with a Carnegie-Mellon Button Box to ensure millisecond-accurate timing of stimulus presentation and response execution.

Procedure

A total of 56 undergraduate students at the University of Sheffield participated in the experiment, receiving a participation sticker in return (students who obtain 20 stickers are allowed to use the scheme for their own research projects). The manipulation of hunger was achieved by manipulating the time of day at which participants were tested. Participants were randomly assigned to one of two hunger conditions, before lunch (hungry) and after lunch (satiated). Those who were asked to take part before lunch were also asked to abstain from eating any food on the morning of the experiment and were tested before lunchtime (between 11:00 hours and 13:00 hours); they were told that they were allowed to drink and if they should need to eat then to do so but to inform the experimenter. Those that were asked to take part after lunch were asked to eat lunch before coming in to take part in the experiment (between 13:00 hours and 14:00 hours). Half of those in each hunger condition were randomly assigned to receive Word List A, the other half received Word List B.

Participants were tested individually. Upon entering the lab, participants were told that the experiment involved a computer task and then completion of three questionnaires, for which they expressed their consent. They were shown to a seat approximately 40 cm in front of a computer screen, in a private cubicle, then presented with the instructions for the lexical decision task on the computer screen.

They then attempted the practice block of six trials. Each item remained on the screen until the participant pressed one of the Button Box response keys (green for words or red for non-words), to indicate whether it was a word or non-word; the next trial followed immediately. After the practice block, participants were allowed to ask any questions, and then began the

experiment proper. The first 10 trials served as buffer items and were followed immediately by the 48 experimental trials.

The experimental trials were presented in a different random order for each participant.

Response latencies for each word were measured from when the item appeared on the screen until one of the response keys was pressed.

After the lexical decision task, participants completed three questionnaires. First, participants indicated how many intrusive thoughts, related to food, they had experienced during completion of the previous task. They then completed a scale (Grand, 1968) in which they were asked to circle a number “to indicate how hungry you feel now”, 0 being “not at all hungry”, and 6 being “extremely hungry”. They also completed the Eating Attitudes Test (EAT-26 factor 1; a standardized 13-item self-report measure of symptoms and concerns characteristic of eating disorders, each of which participants rate on an always-never scale; Garner, Olmsted, Bohr and Garfinkel, 1982), before being fully debriefed as to the aims of the study and given their participation sticker.

Results

EAT scores were used for screening: participants with scores above 10 were excluded from further analyses. This cut off was taken from Garner et al. (1982) who theorised that scores above 10 indicate the presence of disturbed eating patterns, which could itself lead to increased accessibility of food concepts. Six people were excluded on this basis: two from the hungry and four from the satiated condition. Participants in the hungry condition who rated their hunger level as three or less on the hunger scale were excluded in further analyses ($n = 3$). Participants in the satiated condition who rated their hunger level as two or above were also excluded from further analyses ($n = 3$).

Incorrect (‘no’) responses to existing words (food and neutral) were excluded from further analyses (5.14% out of all responses). The mean response latency across the food-related

words and neutral words served as the dependent variables. One participant, from the satiated condition, was excluded from further analyses because their baseline reaction time created an outlier (2317 msec); being more than seven standard deviations above the mean ($M = 919$ msec; $SD = 176$ msec).

Forty-three participants were included in the analyses in total, nineteen in the hungry condition and twenty-four in the satiated condition. The mean hunger levels of these participants were 4.74 ($SE = 0.17$) in the hungry condition and 0.65 ($SE = 0.01$) in the satiated condition.

Lexical Decision Task

[Insert table 1 about here]

A one-between (hungry vs. satiated) x one-within (neutral vs. food words) ANOVA confirmed a significant interaction between hunger condition and word type, $F(1, 40) = 9.78$, $p = 0.003$, $\eta^2 = 0.032$ (with η^2 computed by $SS_{\text{effect}}/SS_{\text{total}}$). The main effect of hunger condition was not significant ($F < 1$). The main effect of word type was significant, $F(1, 40) = 52.89$, $p < 0.001$, $\eta^2 = 0.173$. The means suggest that hunger slowed lexical decisions for neutral words, but not for food-related words, and that response times to food words were faster than neutral words in both groups (Table 1).

Separate between-participant analyses for food-related and neutral words confirmed a marginally significant effect of hunger on decision speed for neutral words, $F(1, 40) = 4.04$, $p = 0.051$, $\eta^2 = 0.092$, but not for food words ($F < 1$).

A priming score was calculated by subtracting the food-related decision times from the neutral decision times. The hungry group had higher priming scores ($M = 171.99$, $SE = 22.88$) than the satiated group ($M = 68.56$, $SE = 112.05$), $t(40) = 3.13$, $p = 0.003$. Priming was positively correlated with hunger, as measured on the hunger scale (Pearson's $r = 0.42$,

$p = .006$): the hungrier a participant, the greater the difference in lexical decision speed to neutral and food words.

Those hungry participants excluded due to high EAT scores showed a similar pattern of results to the main group, however the satiated group were slightly slower for food words than neutral. The sample was too small for statistical analysis.

Intrusive Thoughts

Intrusive thoughts related to food were significantly more frequent in the hungry condition ($M = 4.68$, $SE = 0.7$, range 0 to 10) than in the satiated condition ($M = 2.22$, $SE = 0.29$, range 0 to 4), $t(40) = 3.47$, $p = 0.001$.

A Pearson's correlation revealed a significant positive correlation between hunger and food-related intrusive thought frequency, Pearson's $r = 0.56$, $p = 0.001$. As the level of reported hunger increased so the number of food-related intrusive thoughts increased.

Frequency of food-related intrusive thoughts was positively correlated with priming on the lexical decision task, Pearson's $r = 0.42$, $p = 0.006$. As the frequency of intrusive thoughts increased, so the difference in lexical decision speed to neutral and food words increased.

Frequency of food-related intrusive thoughts showed no correlation with lexical decision speed to either neutral (Pearson's $r = 0.26$, $p = 0.095$) or food words (Pearson's $r = -0.098$, $p = 0.54$).

The correlation between priming on the lexical decision task and intrusive thoughts was reduced when hunger was controlled for (Pearson's $r = 0.25$, $p = 0.06$), but remained in the same direction.

Post-hoc analyses: semantic priming

Hungry participants showed greater priming on the lexical decision task than satiated participants. This could be a result of cognitions associated with craving, as hypothesised.

Alternatively, this could be a result of semantic priming of the food words developing during

the task. While the neutral words also formed a semantic category, being transport related, and so might have benefited from semantic priming; the context of the study might have lent greater salience to the food category. If this was happening, we would expect higher priming scores in the second half of the task, compared to the first. To test this, priming scores were calculated for the two halves of the task, for each participant (see figure 1). The mean priming scores in both halves were greater for hungry participants (1st half $M = 158$, $SE = 40.33$; 2nd half $M = 182$, $SE = 23.91$) than for satiated participants (1st half $M = 65$, $SE = 33.86$; 2nd half $M = 96$, $SE = 36.82$).

[Insert figure 1 about here]

A one-between (hungry vs. satiated) x one-within (first priming vs. second priming) ANOVA confirmed a main effect of hunger condition, $F(1,40) = 7.93$, $p = 0.008$, $\eta^2 = 0.075$; confirming that the hungry participants demonstrated more priming than satiated participants, across both halves. All other results were non-significant ($F < 1$).

Discussion

People who were hungry because they had missed breakfast took longer to respond to neutral words on the lexical decision task, than did satiated participants, who were tested after a morning of normal eating. The responses of hungry participants to food words, however, were as fast as those of the satiated participants. Speeded response times to food words relative to neutral words, i.e. priming, correlated strongly with self-reported hunger and with frequency of food-related intrusive thoughts experienced during the lexical decision.

These results suggest that there are two events that are happening. Firstly, hungry participants demonstrate a slowing to neutral words. Previous research supports this slowing in cognitive performance with hunger (Benton, Slater & Donohoe, 2001; Green, Rogers, Elliman and Gatenby, 1994; Green & Rogers, 1995). Secondly, hungry participants were faster at

responding to the food-related words than the neutral words. Although the speed of response times to food-related items were similar for both conditions, hungry and satiated, the vital difference lies between the neutral and the food-related words in each case. This result suggests a sparing of food words from a general slowing in the hungry participants; compared to the satiated participants, hungry participants were faster at responding to food-related stimuli than neutral stimuli. This speeding in response times to food-related words relative to the neutral words in the hungry participants demonstrate an increased accessibility of food-related items, relative to neutral.

The correlation between intrusive thoughts and priming was weakened when hunger was controlled for. This result is not unexpected, as hunger correlates strongly with intrusive thoughts, and is consistent with the EI explanation of these results. The physiological cue of hunger is expected to increase the accessibility of target-related (food) information in memory, and in turn will increase the likelihood of an intrusive thought.

Food-related words may have primed a food category in semantic memory, and therefore speeding to food words compared to neutral words could be due to greater semantic priming. Hungry people would be more susceptible to this because food items are more salient and preferentially attended (Mogg et al., 1998). However, although the priming scores increase slightly from the first half to the second half of the lexical decision task, this increase is not significant and does not differ across the groups. Hungry people showed greater priming even at the beginning of the lexical decision task. We conclude that the enhanced reaction times to food words, relative to neutral, for hungry participants reflects an increase in availability of food-related information in memory that is due to craving, rather than enhanced semantic priming from exposure to food words during the experiment.

By demonstrating increased priming for food-related concepts with hunger, the present study is consistent with Aarts et al.'s (2001) finding of increased priming for drink-related information during thirst. Our finding is consistent with the idea of increased accessibility,

triggered by internal cognitions and external stimuli, as a precursor of desire and craving (Jarvik et al., 1995; Philips et al., 2004), not just of hunger. Kavanagh, Andrade and May (2005) argue that increased accessibility in craving forms a route to increased craving-related intrusions. The current study is consistent with this claim, demonstrating that intrusive thoughts about food increase in hunger, a state in which craving might occur, and are related to accessibility, as measured by the lexical decision task.

It would be useful to replicate the correlation of accessibility and intrusive thoughts with thirst, in order to establish the reliability of the findings with another motivational state, in which craving may occur. Also, it would be interesting to extend this method to particular domains of craving, for example, craving for a particular food or more addictive cravings such as alcohol. Research currently being conducted by our group is attempting to replicate the present findings with participants who are reporting cravings for specific snack foods, rather than just hunger in general.

The present study is also consistent with work on motivated behaviour more generally. Forster, Liberman and Higgins (2005) demonstrated that goals increase accessibility of related information in memory. In their first study, participants completed four blocks of two tasks; first, they looked through a set of pictures, then they completed a lexical decision task. Participants in the goal condition were instructed to find a picture of a pair of glasses when looking amongst the set. Before goal-fulfilment, the response times from the goal-condition had a greater advantage of goal-related constructs than in the no-goal condition. In the post-fulfilment block (block three), this advantage was reversed to below the baseline level from the no-goal condition. Forster et al. (2005) replicated both of these findings using a Stroop task as well as showing that the observed increase in accessibility persists for as long as the goal remains unfulfilled. These results from Forster et al. (2005) are important because they support the idea that heightened accessibility of related constructs results from motivation, or a goal, which then helps detect stimuli in the environment to aid goal pursuit.

Possible limitations to this study must be considered when drawing conclusions from the results. Due to the nature of the design, participants in the two conditions were tested at differing times of day, before and after lunch. This may have had an adverse effect on the results of the study, as time of day may affect participants' cognition, which could have implications for the lexical decision data. Even though this may be a confounding variable, it should be noted that participants' testing times for both conditions were very close together.

The present findings also have practical implications; priming on the lexical decision task may provide a useful alternative to previous measures of intrusive thoughts. Cognitive research has generally relied on subjective measures of intrusive thoughts, which can interfere with the very experience of the intrusive thought if reporting is done 'on-line'. Giambra (1995) also pointed out that being aware of having to report an intrusive thought can prompt their occurrence, or reporting them can result in their termination. The use of retrospective self-report measures raises concerns about reliability, validity and demand characteristics on the data collected. Also, when intrusive thoughts are reported retrospectively, the apparent incidence of intrusions is subject to effects of manipulations on awareness and memory. For example, thought suppression techniques appear to make intrusions more frequent but they probably also make them more memorable, because intrusions that violate the goal of thought suppression are likely to be more salient than similar thoughts in a 'think about anything' control condition. Despite these limitations, the use of retrospective self-reports can sometimes be unavoidable. Measures provided by alternative correlates to intrusive thoughts, such as hunger questionnaires, may themselves prompt the occurrence of intrusive thoughts. The findings from this study may point toward an alternative to these measures.

Giambra (1995) claimed that an ideal method of measuring intrusive thought experiences will be independent of the person's awareness and not influence the production of the thoughts in any way; but such a method is unobtainable. However, such a method may be realised from this study. Priming measured by the lexical decision task provides a measure of proneness to

the occurrence of intrusive thoughts, and may therefore provide a useful and objective correlate of intrusive thoughts that could be used to test the effects on intrusion frequency of manipulations such as thought suppression independently of their effects on deliberate recall.

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Appendix. Word lists used for the lexical decision task

practice items

Terminal
Caravan
Gondola

buffer items

Aeroplane
Deck
Clutch
Ticket
Pedal

List A

<i>neutral</i>	<i>nonword</i>
Bicycle	Aocket
Brake	Cailway
Buggy	Corry
Coach	Gane
Crew	Joachman
Dinghy	Larf
Ferry	Lart
Fleet	Oailor
Fuel	Railor
Glider	Randwich
Harbour	Rar
Kayak	Rauge
Motor	Saxi
Track	Taft
Truck	Treese
Wagon	Whomach

List B

<i>neutral</i>	<i>nonword</i>
Aircraft	Bew
Cart	Breal
Coachman	Buel
Gauge	Cabour
Jet	Cricycle
Lorry	Daste
Lane	Fack
Oar	Flunch
Railway	Fuggy
Rocket	Glack
Raft	Hiscuits
Rails	Kotor
Sailor	Mocolate
Taxi	Troach
Trailer	Trook
Wharf	Wuck

<i>food</i>	<i>nonword</i>
Biscuits	Chood
Chocolate	Cret
Cook	Dat
Hungry	Eircraft
Lunch	Finner
Meal	Seet
Snack	Stisps
Taste	Swails

<i>food</i>	<i>nonword</i>
Cheese	Binghy
Crisps	Chake
Dinner	Cerry
Eat	Hayak
Food	Lagon
Sandwich	Mungry
Stomach	Sneet
Sweet	Tider

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Table 1: Mean latencies (milliseconds) as a function of condition and word type

Word type	Condition			
	Hungry		Satiated	
	Mean	SD	Mean	SD
Food-related	690	122	706	117
Neutral	862	150	774	132
Neutral – food	172	100	69	112

Figure 1: Mean priming scores (milliseconds) as a function of task half and condition (standard error bars)

