The Effect of Chocolate-Craving on Long-Term Memory

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Abstract

By replicating the craving induction used in Tiggemann, Kemps, and Parnell’s (2010) experiment, I was able to test the effects that take place at the long-term memory level. The influence of craving between subjects (induced chocolate craving condition vs. control condition using coloured blocks) on undergraduate students’ results on both word-recall and word-fragment memory tasks (within subjects) \((N=25)\) was examined. Induced chocolate cravers performed significantly more poorly on both explicit word-recall and implicit word-fragment tasks than did controls. The practical implication of findings from this study can provide enough evidence to assume that visually interacting with chocolate effects learning and should be used with discretion in the classroom or workplace in which complex cognitive tasks are performed.
The Effect of Chocolate-Craving on Long-Term Memory

Foods high in sugar have addictive properties; they can cause craving until the need is met (Baker, Morse, & Sherman, 1986). The term ‘craving’ describes a motivational state in which an individual feels compelled to seek and ingest a particular substance (Baker, et al.). An example is chocolate, which may be the most craved food (Hetherington & Macdiarmid, 1993). This does not come as a surprise, as the hedonic appeal of chocolate derives from its sugar-to-fat ratio and its texture (Drewnowski & Greenwood, 1983). Consuming chocolate increases serotonin production and releases endorphins, making the consumer feel good after he or she eats it (Benton, 2004). Chocolate consumption is largely due to psychological triggers such as depression (Willner, Field, Pitts, & Reeve, 1998) instead of physiological triggers and hunger deficiencies like most other foods (Pelchat, 2002). The difference between hunger and craving depends on the intensity of the desire, a learned response that is not innate (Hetherington & Macdiarmid, 1993). Chocolate is highly craved, thus demanding attention and taking up limited cognitive resources at the working memory level with potential impairments at the long-term memory (LTM) level.

Craving can give rise to negative consequences such as guilt following unwanted consumption (Macdiarmid & Hetherington, 1995), binge eating (Gendall, Joyce, Sullivan, & Bulik, 1998), and early dropout from weight-loss programs (Sitton, 1991). Recent research shows a further consequence: food cravings may impair cognitive performance (Kemps & Tiggemann, 2007).

Food cravings interfere with cognitive tasks because working memory has a limited capacity. For example, chocolate craving-related thoughts often take precedence over other,
potentially more important information to be stored (Kemps, Tiggemann, & Grigg, 2009). This hinders absorption of material at the input level and interferes with task performance at the output level when information is needed for recollection (Kemps, Tiggemann, & Grigg, 2009). Chocolate-related stimuli are perceived as attractive and demand attention drawing attention away from other stimuli (Kemps & Tiggemann, 2007).

Researchers who focus on the study of working memory use attention and reaction time as a focus of measurement. Adaptation to environmental cues occurs at the sensory processing level before being received at the working memory level (Baddeley & Hitch, 1974). If information is successfully attended to, it may be encoded in the long-term memory store for later retrieval. The most supported model of working memory is that of Baddeley and Hitch (1974) who focused on three main components of input, processing, and output during memory. The working memory triad includes the central executive, the phonological loop and the visuo-spatial sketch pad (Baddeley & Hitch, 1974). The central executive mediates information from both the phonological loop and the visuo-spatial sketch pad and accounts for the attentional control system responsible for updating information (Baddeley & Hitch, 1974). The phonological loop and the visuo-spatial sketch pad compete for verbal and visual processing that occurs simultaneously; there is limited storage capacity in the working memory vessel (Tiggemann, Kemps, & Parnell, 2010). The working memory model is particularly significant because researchers have examined craving-induced learning deficits on respective areas.

The visuospatial sketchpad processes visual and spatial information in the world for understanding at the working memory level. Tiggemann, Kemps, and Parnell (2010) found evidence that chocolate craving stems mainly from visual stimuli. They examined the effect of visual stimuli using tasks that incorporated the visuo-spatial sketchpad to measure a potential
deficit after inducing chocolate craving in female undergraduate students. Participants who experienced chocolate cravings performed significantly worse than those who did not experience such cravings (Tiggemann, et al.). The relevance of inducing chocolate craving and measuring the visuo-spatial sketchpad is that chocolate craving is often induced as a marketing scheme, via commercials and billboards.

Distraction that occurs at the working memory level may be due to the presence of chocolate but could also be a visual distraction (which happens to be chocolate). Tiggemann, Kemps, and Parnell (2010) asked half of their participants to refrain from eating chocolate twenty-four hours prior to participating in a study (craving group). Participants in the craving condition were given a chocolate bar to unwrap and have in front of them while completing a working memory task on the computer screen (Tiggemann, et al.). Participants in the control group completed an identical working memory task but with a coloured block as a distraction instead of chocolate. They found that the craving group performed significantly worse on the working memory task than did the control group. These results indicate that it is, in fact a highly-craved food, in this case chocolate and not just a visual distracter that causes the impairment.

While the effects of craving on working memory have been examined thoroughly, the potential effects of craving on long term memory (LTM) have not been addressed. There are working memory deficits due to craving so it is possible to see learning deficits by inducing the same craving. If so, there may be a far greater strain put on learning that stems beyond the working memory level.

In general there are two types of LTM: explicit and implicit (Tulving, 1972). Tulving’s theory of encoding specificity states that to access episodic and semantic memory: specific
events in time and facts about the world, one must use retrieval cues during encoding similar to retrieval cues during activation of previously learned information. As noted, LTM deficits have not been demonstrated in craving conditions.

The purpose of the current study is to compare LTM recall with participants who experience induced chocolate craving and individuals who do not. In keeping with previous research by Tiggemann et al. (2010), an elicited craving is induced using chocolate bars.

Forgetting may be caused by a lack of appropriate retrieval cues such as hindered working memory, Tulving (1972) found evidence to support his encoding specificity principle with cued recall experiments using word lists. Forgetting may also be caused by a failure to encode an item in the first place. The storage in working memory is limited and distraction uses cognitive resources, restricting the information available for transfer to LTM storage for later retrieval. The present experiment tests decrements in long term memory storage stemming from working memory impairments using two well-established tasks of encoding—a word recall task to test explicit memory and a word fragment task to test implicit encoding of previously seen words in the recall list.

Method

Participants

Participants included 25 undergraduate students from Algoma University. Fourteen of the twenty-five participants were introductory psychology students, three were male participants and 22 were female participants. Students were recruited via the Algoma University daily e-mail.
Design

A mixed 2 x 3 experimental design was used in the experiment. The between-subjects factor was condition (craving x control), and the repeated-measures factor was memory task (word recall list, word recall task, word fragment task). Participants were randomly allocated (subject to equal ns) to the craving or control condition.

Materials and Procedure

Materials used in our study included a seventeen inch laptop for memory task usage. Seven chocolate bars (Mars, Bounty, Crunchie, Aero, Aero Mint, Kit-Kat, and Jersey Milk) or seven coloured blocks (either blue, green, red, yellow, or light blue) which were put into a white wicker basket for the between-subjects craving induction.

Following craving-induction protocol by Tiggemann, Kemps, and Parnell (2010), participants randomly assigned to the craving group were instructed to choose their favourite chocolate bar from the basket, unwrap it, and place it on the napkin to the left of the laptop screen. Participants in the control condition were instructed to choose their favourite coloured block from an identical basket, and place it on the napkin to the left of the laptop screen.

Coloured blocks were used in the control condition to ensure that it was chocolate potentially causing distraction and not just any object. The coloured blocks used in this experiment are similar in shape and size to the chocolate bars used. As evidence concerning cigarette craving indicates that cue exposure is maximally effective if the participant interacts with the craving induction stimulus (Baxter & Hinson, 2001), participants were instructed to actively engage with the chocolate by unwrapping it before completing the memory tasks.
Participants were tested on an individual basis in the psychology department at Algoma University in a session running for about fifteen minutes. As cravings occur more frequently after midday, (Hill, Weaver, & Blundell, 1991) participants were tested between the hours of 11:30AM and 4:00PM.

All participants partook in all three memory tasks. The first part of the study was a word recall paradigm in which twenty words appeared on the computer screen for three seconds each using Microsoft Word (Redmond, WA). Participants were explicitly informed they would have to recall the twenty words in no particular order later in the study. All words were common nouns or adjectives between six and ten letters (n=20). Words were written in Calibri font, size 130 and bolded, with a white background to diminish any level of distraction. The two tasks that followed were counterbalanced to account for order and included both a word recall task to measure explicit memory and a word fragment task to measure implicit memory.

Explicit: Explicit memory was assessed using a word-recall task in which participants were instructed to write down as many words as they could remember that were previously viewed during the slideshow. Words were to be written down in no particular order and four minutes was allotted to each participant for this task.

Implicit: Implicit memory was measured via a word-fragment task in which participants were asked to complete words. Each word was presented in Microsoft PowerPoint (Redmond, WA) for five seconds each (n=20) but 2-4 letters in each word were replaced with underscores. Participants were instructed to state known words aloud within the five second time frame. Ten of the twenty words were previously perceived in the word recall paradigm (primed) and ten
were new words (unprimed). Participants were informed the word-fragment assignment was a distracter task and had no correlation to the research study.

Concluding the craving-induction and implicit and explicit task procedures, participants were informed of the ramifications surrounding the study in a debriefing procedure. Participants were allowed to take a chocolate bar at the end of the experiment as long as signed consent stated that there were no known allergies.

**Results**

To measure the effect of craving manipulation on cognitive performance, an independent samples t-test for equality of means was carried out for each of the two groups (implicit and explicit results). Raw implicit scores were calculated by adding all correct primed words (/10); unprimed words were disregarded. Raw explicit scores were calculated by adding all correct words recalled (/20). An alpha level of $p < 0.05$ was set for all statistical analyses.

**Effect of Implicit Score**

The raw implicit score on the t-test (assuming unequal variances) indicates statistical significance of craving distraction on word-fragment performance. Specifically, participants who were induced chocolate cravers performed more poorly on the word-fragment task ($M = 5.85, SD = 1.17$) than participants who were in the control condition ($M = 7.67, SD = 1.44$) [$F (2, 22) = 0.012, p < 0.05$].

**Effect of Explicit Score**

The raw explicit score on the t-test (assuming unequal variances) indicates statistical significance of craving distraction of word-recall performance. Specifically, participants who were induced
chocolate cravers performed more poorly on the word recall task ($M = 7.77, SD = 1.17$) than participants who were in the control condition ($M = 9.50, SD = 2.15$) [$F (2, 16) = 0.025, p < 0.05$].

**Discussion**

In line with previous literature and Tiggemann, Kemps, and Parnell’s (2010) findings, experimentally induced chocolate cravings decreased performance on word recall tasks. Although all participants were explicitly given the same message about recalling words at a later time, the control group recalled more words than the craving group. The working memory store has a limited capacity for resources, and as seen in this experiment, chocolate cravings compete for cognitive attention causing a bias and attentional deficit.

However, the present experiment goes one step further than in previous literature by locating a learning deficit that takes place at the long-term memory level. In so doing, the findings support both the proposal that food cravings are primarily visual in nature (Tiggemann, Kemps, Parnell, 2010) and the application of the implicit memory model to food cravings. Participants in the control condition learned more of the primed words even though they were consciously unaware of seeing them previously. Induced chocolate-cravers recalled less primed words than the control condition, which shows a learning curve for the control group.

It was not until the 1960’s when implicit memory was examined, as prior belief in unconsciousness was left to Freud (Kihlstrom, Dorfman, & Park, 2007). Amnesiac patients were instructed to study a list of words similar to the explicit word-recall task done in this study (Warrington & Weiskrantz, 1968). Compared to the control condition, patients with Amnesia performed significantly poorer on recall and recognition (Warrington & Weiskrantz). However,
when presented with word-fragments and asked to simply complete the cues with the first word that came to mind like in this study, amnesiacs and controls were equally likely to complete the cues with items from the previously studied list (Warrington & Weiskrantz). The priming effect that took place in 1968 is very similar to the priming effect in this particular study as the prime facilitated processing of the target, indicating the studied items were encoded in memory, retained in storage, and influenced on completion of the word-fragment task (Kihlstrom, Dorfman, & Park).

Amnesiacs did not perform equally on explicit and implicit tasks, indicating that priming can be dissociated from conscious recollection and thus implicit memory can persist in the absence of explicit memory. Schacter (1987) distinguished between explicit and implicit memory by stating explicit memory involves conscious recollection (word-recall task) and implicit memory refers to any effect of an event on subsequent experience (word-fragment task). In contrast, our study found a variable that effects explicit and implicit memory the same way: chocolate. It is important to note that induced chocolate-cravers performed poorly on both explicit and implicit memory tasks.

The extent to which chocolate craving affects learners does have some practical implications. Eating foods high in sugar such as chocolate has the potential to cause a habitual need for more, a craving of that particular food. Also, if we were able to induce craving experimentally by asking participants to unwrap chocolate bars, the natural environment is saturated with similar cues and has the potential to easily induce craving. Individuals who are induced to crave in a natural setting may experience difficulty with cognitive task performance at the working memory level when attention is needed (Tiggemann, Kemps, & Parnell, 2010) as well as when trying to recall previous material that was not properly learned due to craving.
School and workplace cafeterias make purchasing chocolate easy and accessible, especially because vending machines usually always carry chocolate. This is problematic because seeing these types of foods in the learning environment hinders recall of material that would have otherwise been primed.

There are opportunities for growth in the development of extended research. It was difficult to recruit enough male participants to make a significant comparison across sex, as the sample size consisted of mainly female participants. Trait chocolate craving was not assessed in this particular study but the implications for measuring level of craving while completing memory tasks is valid. Benton, Greenfield, and Morgan (1998) developed an Attitudes to Chocolate Questionnaire in which ten statements regarding thoughts, feelings, and behaviours toward chocolate were assessed. Future research needs to examine the present findings without inducing chocolate craving experimentally. It would be beneficial to measure the effect of naturalistic craving on subsequent tasks such as those induced during commercials.

Despite these limitations, we have developed a model of measuring craving differences by measuring explicit and implicit memory. We have also found a variable that hinders implicit memory similar to the brain damage experienced in amnesiacs when completing the same task. Specific branches of long-term memory can now be examined further to measure the exact time deficit that may occur during craving.
References


