

2014-05

# Playing 'Tetris' reduces the strength, frequency and vividness of naturally occurring cravings

Skorka-Brown, J

<http://hdl.handle.net/10026.1/2925>

---

10.1016/j.appet.2014.01.073

Appetite

Elsevier BV

---

*All content in PEARL is protected by copyright law. Author manuscripts are made available in accordance with publisher policies. Please cite only the published version using the details provided on the item record or document. In the absence of an open licence (e.g. Creative Commons), permissions for further reuse of content should be sought from the publisher or author.*

1 Skorka-Brown, J., Andrade, J. & May, J. (2014). Playing 'Tetris' reduces the strength,  
2 frequency and vividness of naturally occurring cravings. *Appetite*, 76, 161-165.  
3 <http://dx.doi.org/10.1016/j.appet.2014.01.073>

4

5 Playing 'Tetris' reduces the strength, frequency and vividness of naturally occurring  
6 cravings

7 Jessica Skorka-Brown

8 Jackie Andrade

9 Jon May

10 School of Psychology, Cognition Institute, Plymouth University, UK

11

12 Address for correspondence: Professor Jackie Andrade, School of Psychology,  
13 Cognition Institute, Plymouth University, Drake Circus, Plymouth, PL21 0XP, UK

14 Email: [jackie.andrade@plymouth.ac.uk](mailto:jackie.andrade@plymouth.ac.uk)

15

16 Running head: Naturally occurring cravings

17 Keywords: working memory; food craving; sensory imagery; intervention; motivation

18 Word count: 3647

19

1 Abstract

2 Elaborated Intrusion Theory (EI) postulates that imagery is central to craving, therefore a  
3 visually based task should decrease craving and craving imagery. This study provides  
4 the first laboratory test of this hypothesis in naturally occurring, rather than artificially  
5 induced, cravings. Participants reported if they were experiencing a craving and rated the  
6 strength, vividness and intrusiveness of their craving. They then either played 'Tetris' or  
7 they waited for a computer program to load (they were told it would load, but it was  
8 designed not to). Before task completion, craving scores between conditions did not  
9 differ; after, however, participants who had played 'Tetris' had significantly lower craving  
10 and less vivid craving imagery. The findings support EI theory, showing that a  
11 visuospatial working memory load reduces naturally occurring cravings, and that Tetris  
12 might be a useful task for tackling cravings outside the laboratory. Methodologically, the  
13 findings show that craving can be studied in the laboratory without using craving  
14 induction procedures.

15 157 words

16

17

18

## 1 Introduction

2           Although cravings are an everyday occurrence amongst the general population  
3 (Lafay et al., 2001) they are linked to a variety of negative effects, even when they are  
4 resisted; for example, by causing distress and distraction (Green, Rogers & Elliman,  
5 2000). Craving can also be a precursor to binge eating in the general population  
6 (Gendall, Joyce, Sullivan & Bulik, 1998), early dropout from weight loss program's  
7 (Sitton, 1991), and the development of obesity (Schlundt, Virts, Sbrocco, & Pope-Cordle,  
8 1993).

9           Elaborated Intrusion Theory (Andrade, May & Kavanagh, 2012; Kavanagh,  
10 Andrade & May, 2005; May, Andrade, Kavanagh & Hetherington, 2012) conjectures that  
11 craving is principally a working memory process where affectively-charged sensory  
12 images are maintained primarily in the visuo-spatial sketchpad. An internal or external  
13 trigger leads to a spontaneous thought that, depending on its salience and on current  
14 cognitive demands, will either be elaborated or ignored. When elaboration occurs,  
15 images are developed, maintained and elaborated using internal and external  
16 information (for example, recalling memories of previously eating chocolate). Previous  
17 research has shown that visual images are central to craving imagery, although other  
18 senses are also involved. In Kavanagh, May, and Andrade's (2009) study, respondents  
19 on an alcohol dependence programme reported an average of 2.3 sensory modalities in  
20 their alcohol craving imagery. May, Andrade, Pannaboke and Kavanagh (2004) found  
21 over 60% of respondents reported visualising or tasting the substance they were craving.

22           Visual and auditory imagery load the limited-capacity, modality-specific slave  
23 systems of working memory, the visuospatial sketchpad and phonological loop  
24 respectively (Baddeley & Andrade, 2000). Involvement of these slave systems in a task  
25 can be blocked by irrelevant task loads such a task involving spatial manipulation or

1 visual distraction in the case of the visuospatial sketchpad, or a verbal task in the case of  
2 the phonological loop. In support of the EI theory hypothesis that visual imagery is a key  
3 component of craving, there is accumulating evidence that visuospatial loads or  
4 competing neutral visual images selectively reduce craving, for cigarettes (May,  
5 Andrade, Panabokke, & Kavanagh, 2010; Versland & Rosenberg, 2007) and for food  
6 (Andrade, Pears, May & Kavanagh, 2012; Harvey, Kemps & Tiggemann, 2005; Kemps  
7 & Tiggemann, 2007; Kemps, Tiggemann & Hart, 2005; Kemps, Tiggemann, Woods &  
8 Soekov, 2004; McClelland, Kemps and Tiggemann, 2006; Steel, Kemps & Tiggemann,  
9 2006).

10 Van Dillen, Nordgren, and Andrade (2013) used the visuospatial task of playing  
11 the computer game Tetris to block craving for food. Stuart, Holmes and Brewin (2006)  
12 had used this task to block encoding of visual images while participants watched a  
13 traumatic film; in the week that followed the film, participants experienced fewer intrusive  
14 images from segments of the film during which they had played Tetris than from other  
15 segments of the film. Holmes, James, Coode-Bate and Deeptose (2009) found similar  
16 reductions in intrusive imagery when Tetris was played after viewing the traumatic  
17 material. In Van Dillen et al.'s study, Tetris reduced attentional biases to food pictures,  
18 reduced craving, and led to fewer participants choosing chocolate or marzipan as a  
19 reward rather than a piece of fruit. Tetris is assumed to load heavily on visuospatial  
20 working memory because it requires the player to rotate and move geometric shapes  
21 rapidly in order to complete rows of shapes without leaving gaps. It is easy to access  
22 over the internet, giving it the potential to be used as a take-home task to help people  
23 manage craving or traumatic imagery.

24 We aimed to replicate van Dillen et al.'s (2013) finding, with an important  
25 difference. Previous studies of craving in the laboratory, including those cited above,

1 have induced cravings when participants have come into the laboratory. For example,  
2 Andrade, Pears et al. (2012) asked participants to inspect and evaluate chocolates; van  
3 Dillen et al. (2013) asked participants to select items from a menu. The reasoning behind  
4 craving inductions is that the novelty and cognitive demand of the laboratory setting may  
5 itself reduce cravings, even when participants have abstained from the substance prior to  
6 taking part in the study. There is a risk, though, that working memory loads are doing  
7 nothing more than removing an artificially induced desire. We therefore recruited an  
8 unselected sample and aimed to measure and manipulate any naturally occurring  
9 cravings that they were experiencing.

10 Naturally occurring cravings might be more resistant to intervention because  
11 they are triggered by physiological deficit or conditioned cues. We therefore wanted to  
12 maximize the chance of finding an effect of visuospatial interference by comparing Tetris  
13 against a condition with minimal working memory demands, but at the same time we  
14 needed a control condition that would ensure that participants did not become distracted  
15 by anything else in their environment and would not be aware that they were in the  
16 control group. We therefore followed van Dillen et al. (2013) by using a 'wait' condition.  
17 Van Dillen et al. told participants that the computer was old and the programme might  
18 take a while to load. They looked at a blank screen while waiting. In our study,  
19 participants saw a fake load screen that appeared to be showing Tetris loading, but  
20 never actually loaded.

21 Van Dillen et al. (2013) used behavioural measures of craving, that is, response  
22 biases to tempting foods and food choices at the end of the experiment, and a four-item  
23 craving scale. We used the Craving Experience Questionnaire (CEQ; Andrade, Pears et  
24 al., 2012; May et al., 2013) developed from the Alcohol Craving Experience  
25 questionnaire (Kavanagh, May & Andrade, 2009; Statham et al., 2012), to assess

1 craving phenomenology in the control and intervention conditions. The CEQ provides a  
2 measure of craving strength, imagery, and intrusiveness. We also asked participants if  
3 they were under the influence of alcohol (including being hung-over) to check if this was  
4 a confounding variable, because Burton and Tiffany (1997) found that when people had  
5 consumed alcohol they had a general increase in craving compared to when they had  
6 not.

7

## 8 Method

9

### 10 Participants

11 A total of 121 (27 males) participants from Plymouth University Undergraduate  
12 Participation Pool were recruited, aged between 18 and 30 years ( $m = 19.74$  years), in  
13 partial fulfillment of a course requirement to participate in research.

14

### 15 Design

16 The design was a between subjects quasi experiment. Participants were  
17 randomly assigned to one of two conditions (experimental or control) prior to taking part.  
18 They were then allocated to either a craving or not craving group depending on the  
19 craving level they reported on entering the lab.

20

### 21 Materials

22 A Samsung 10.1inch Netbook was used to display the load screen. This  
23 'program' was written in Microsoft PowerPoint and used a timed slideshow to show a  
24 'load bar' slowly progressing, and then a message saying 'Load Error'.

1 Tetris was played on a 15inch computer monitor with a standard keyboard. The  
2 computer game 'Tetris' was downloaded from [www.80smusiclyrics.com/games/html](http://www.80smusiclyrics.com/games/html)

3  
4 Participants rated their craving on a single-item scale of 1 (not craving at all) to  
5 100 (craving something very much). More detailed information about craving  
6 phenomenology was collected using the Craving Experience Questionnaire (CEQ;  
7 Andrade, Pears et al., 2012; May et al., 2013), adapted to encompass any sort of craving  
8 rather than just craving for chocolate. The CEQ-S<sub>now</sub> asked participants to rate the  
9 strength, imagery vividness, and intrusiveness of their current craving on an eleven point  
10 scale anchored 'Not at all' and 'Extremely'. A typical question for assessing craving  
11 strength was 'Right now, how strongly do you want it?', for imagery 'Right now, how  
12 vividly do you picture it?', and for intrusiveness 'Right now, how hard are you trying not to  
13 think about it?'. This questionnaire provided a snapshot of craving experience  
14 immediately before the experimental period began. The CEQ-S<sub>then</sub> assessed craving  
15 experience during the experimental period (load screen or Tetris). It asked the same  
16 questions but retrospectively, in relation to the period since participants completed the  
17 CEQ-S<sub>now</sub> during which they were playing Tetris or watching the load screen. For  
18 example, the imagery item became 'During that time, how vividly were you picturing it?'.  
19 The CEQ-F<sub>then</sub> used similarly phrased questions to ask participants to rate the *frequency*  
20 of their cravings, images, and intrusive thoughts during the period since doing the CEQ-  
21 S<sub>now</sub>, on an eleven point scale anchored 'Not at all' to 'Constantly', for example, 'During  
22 that time, how often did you picture it?'. The 'then' versions of the CEQ were used to  
23 assess changes in craving experience while participants were playing Tetris, rather than  
24 taking a snapshot of craving once the game ended, to avoid contamination by a re-



1 kindling of craving once the interference ended. Andrade, Pears et al. (2012) and May et  
2 al. (2013) reported Cronbach's alpha ratings over 0.90 for each scale.

3

4 Procedure:

5

6 The study was approved by the Plymouth University Faculty of Science and  
7 Technology Research Ethics Committee. Participants were tested between 9am and  
8 4.45pm, to allow for variance in cravings across the day (Hill, Weaver & Blundell, 1991).  
9 Participants were also tested in pairs to control for time of day effects, with one person in  
10 each pair assigned randomly to each task.

11 After being briefed, participants completed a short questionnaire asking for their  
12 demographic information. They were then asked what, if anything, they were craving and  
13 completed the CEQ-S<sub>now</sub> in relation to their craved substance or activity.

14 Participants then either played 'Tetris' or waited for a screen to load, according to  
15 their random allocation. The 'load screen' program was designed so that 'Tetris' never  
16 loaded and ended with a 'Load Error' message. Both tasks took 3 minutes. To ensure  
17 that the participants did not realise that the 'load screen' was a control measure it was  
18 loaded on a Netbook and then passed to the participant with the 'program' having  
19 started. Participants in this control condition were told that the experimenter had written  
20 the program to run 'Tetris' with features that the 'normal Tetris' did not have.

21 Next, participants completed the CEQ-S<sub>then</sub> and CEQ-F<sub>then</sub> to assess their craving  
22 experience during the load screen or Tetris period. Finally, they were asked if they were  
23 aware of the condition to which they had been assigned. Note that participants who  
24 reported not craving anything, still completed all parts of the experiment, answering N/A  
25 to craving questions.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24

Results:

A total of 121 participants were tested. Two people reported being aware of their assigned condition and their results were removed from the analysis. Of the 119 participants remaining, 80 reported craving something (58 food or drink, 10 caffeine, 12 nicotine) and 39 were not craving anything. Data from participants who reported no craving are not analyzed further. Hill, Weaver and Blundell (1991) found that cravings were typically higher in the afternoon compared to other times of day, but a chi-square analysis found no relationship between time of day and number of participants reporting craving:  $\chi^2(1, N=119) = 0.280, p = .299$ , therefore time of day is not analyzed further.

Craving was measured by a single-item scale before and after participants had completed their assigned task (Table 1).

---

Insert Table 1 about here

---

The effect of task on craving was examined using a 2(time) x 2(task condition) repeated measures ANOVA. Craving reduced over time,  $F(1,78) = 14.26, p < .001, \eta_p^2 = .16$ . The main effect of condition was not significant,  $F < 1$ , but there was the predicted interaction between condition and time with greater reduction in craving for the Tetris condition than for the load screen condition,  $F(1,78) = 5.67, p = .020, \eta_p^2 = .07$ . The interaction remained significant after removing nine participants with weak craving defined as a score below 20 on the single-item craving scale ( $N = 3$ ) and/or who reported being under the influence of alcohol ( $N = 7$ ),  $F(1,69) = 5.17, p = .026, \eta_p^2 = .07$ , and

1 when only participants' craving food or drink were considered,  $F(1,56) = 12.17, p = .001,$   
2  $\eta_p^2 = .18.$

3 To obtain a more detailed picture of craving change, participants' responses on  
4 the CEQ<sub>now</sub> and CEQ<sub>then</sub> were averaged across factors, to give scores for craving  
5 strength, imagery, and intrusiveness (see Andrade, Pears et al., 2012; May et al., 2013).  
6 These data were subjected to 2(time) x 2(task condition) repeated measures ANOVAs.

---

8 Insert Table 2 about here

---

9  
10 A 2(time) x 2 (condition) repeated measures ANOVA was used to compare  
11 before (now) and after (then) scores from the CEQ questionnaires. The main effect of  
12 condition on craving strength was not significant,  $F < 1$ . Craving strength reduced over  
13 time,  $F(1,78) = 18.71, p < .001, \eta_p^2 = .19,$  and the interaction showed that this reduction  
14 was larger for the Tetris condition,  $F(1,78) = 9.60, p = .003, \eta_p^2 = .11.$  Craving imagery  
15 showed a similar null effect of condition overall,  $F < 1,$  and reduction over time ( $F(1, 78) =$   
16  $39.02, p < .001, \eta_p^2 = .33)$  and interaction between time and condition ( $F(1, 78) = 11.29,$   
17  $p = .001, \eta_p^2 = .13).$  Craving intrusiveness also showed no main effect of condition,  $F(1,78)$   
18  $= 1.46, p = .23, \eta_p^2 = .02,$  and a significant reduction over time,  $F(1, 78) = 20.73, p < .001,$   
19  $\eta_p^2 = .21,$  but the interaction did not reach statistical significance,  $F(1, 78) = 1.17, p = .28,$   
20  $\eta_p^2 = .02).$

21 A one way ANOVA of scores on the CEQ-F<sub>then</sub> showed that participants  
22 experienced less frequent cravings and less frequent craving imagery while playing  
23 Tetris than while watching for the load screen,  $F(1, 78) = 7.53, p = .008, \eta_p^2 = .09,$  and  
24  $F(1, 78) = 15.91, p < .001, \eta_p^2 = .17$  respectively. The frequency of craving-related intrusive

1 thoughts differed in the same direction but the difference fell just short of statistical  
2 significance ( $F(1, 78) = 3.80, p = .055, \eta_p^2 = .05$ ).

3

#### 4 Discussion

5 This study examined naturally occurring cravings and to our knowledge is the  
6 first experimentally-controlled laboratory manipulation of natural rather than artificially-  
7 induced cravings. Kemps and Tiggemann (2013) recently reported that a visual  
8 interference task reduced naturally-occurring cravings for food in the field, but did not  
9 include a control condition to test that the craving reductions exceeded those that would  
10 happen naturally during the time taken to complete the task. The load-screen condition in  
11 the present study performed this function.

12 The findings show that studying naturally-occurring cravings, rather than inducing  
13 cravings artificially, is a viable option for laboratory research. Around two-thirds of  
14 participants reported craving something at the time of completing the experiment and  
15 their mean craving levels were reasonably high, around the mid-way point on the  
16 baseline single-item craving and CEQ measures. It is possible that our predominately  
17 young, female, undergraduate sample experienced stronger cravings than the general  
18 population because cravings decrease in strength and frequency with age and women  
19 typically experience more cravings than men (Lafay et al., 2001; Pelchat, 1997). In an  
20 ecological momentary assessment study of a somewhat broader sample (73% university  
21 students), participants reported a current desire on 50% of the sampling occasions and a  
22 recent desire on a further 28% of occasions. As in the present study, desires to eat or  
23 drink were the most frequently reported (36.7%; Hofmann, Baumeister, Förster, & Vohs,  
24 2011). In contrast to previous research (Hill, Weaver and Blundell, 1991), there was no  
25 change in craving frequency across the day.

1           Playing Tetris for 3 minutes reduced craving strength and craving image  
2    vividness compared with watching a load screen. This finding supports Elaborated  
3    Intrusion Theory (Kavanagh et al., 2005), which posits that imagery is central to craving  
4    and that the development, maintenance and elaboration of craving images requires  
5    working memory resources, and in particular visuospatial working memory. Van Dillen et  
6    al. (2013) found that Tetris reduced behavioural indices of craving following a craving  
7    induction, specifically attentional biases to food pictures and choice of high calorie rather  
8    than fruit snacks, as well as self-reported craving. The present study extends their  
9    findings by showing that Tetris weakens naturally occurring cravings, with the implication  
10   that other previous studies of effects of working memory loads on craving (e.g., Andrade,  
11   Pears et al., 2012; Kemps & Tiggemann, 2007; May et al., 2010) should also generalise  
12   to ecologically valid cravings.

13           The findings support the prediction of EI theory that visuospatial tasks weaken  
14    cravings via effects on craving imagery, by showing that playing Tetris reduced the  
15    vividness and frequency of craving imagery. However, they do not rule out an  
16    interpretation that any working memory load would have the same effect, regardless of  
17    sensory modality. It remains to be tested whether the effects of Tetris on craving are due  
18    specifically to visuo-spatial interference, or to general task demands. Previous research  
19    has shown effects of visual tasks over non-visual working memory tasks assumed to  
20    impose similar executive processing loads. For example, May et al. (2010) reported  
21    reductions in cigarette craving when participants imagined neutral visual scenes  
22    compared with when they imagined neutral sounds. In the field, Knäuper, Pillay, Lacaille,  
23    McCollam, & Kelso (2011) showed that positive visual imagery reduced food cravings  
24    over a four-day period compared with reciting the alphabet backwards, a reasonably  
25    demanding verbal working memory task. These findings suggest that the visuospatial

1 component of playing Tetris might give benefits over and above those of an equally  
2 difficult verbal task, but this prediction has not yet been tested.

3           There is a risk that temporary reductions in craving might lead to later increases.  
4 Distraction tasks can increase the 'ironic' effects of thought suppression, leading to  
5 behavioural rebound (Erskine, 2008). Although we did not test the long-term impact of  
6 playing Tetris, we think it is unlikely to lead to increased craving or consumption in the  
7 longer term, for three reasons. First, there is evidence that other visuospatial interference  
8 tasks reduce craving and consumption over periods of weeks (Kemps & Tiggemann  
9 2013; Knäuper et al., 2011). Second, participants did not receive the thought  
10 suppression instructions that are typically associated with rebound effects. Third,  
11 Casselli, Soliani and Spada (2013) incidentally included Tetris as a resting phase  
12 following manipulations of thought focus in the laboratory. Overall, craving did not  
13 increase over the next three days, during which participants continued using their  
14 assigned thought focus strategy, suggesting that Tetris did not lead to a rebound. There  
15 appeared to be an increase in craving in one 'distraction' condition, where participants  
16 focused their thoughts on geographical locations. Casselli et al. did not report how often  
17 participants used this distraction technique over the three days, or whether they thought  
18 about locations associated with their desired activity. Nonetheless, this finding raises the  
19 concern that any distraction might lead to increases in craving over time because, as  
20 Casselli et al. suggest, participants can learn to use it as a thought avoidance strategy.  
21 We suggest that the two tasks are rather different, with Casselli's directing people's  
22 thoughts to a neutral topic and ours specifically loading the visuospatial working memory  
23 processes that people need for elaborating craving images. Future research should test  
24 the long-term impact of craving interventions and test whether that impact differs  
25 according to the type of distraction employed. Elaborated Intrusion theory predicts that

1 tasks that specifically load working memory processes needed for craving imagery will  
2 help break the vicious cycle of desire-related thoughts leading to desire imagery, which  
3 leads to more desire thoughts. Predictions about the effects of more general distractions  
4 are mixed: Instructions to think about other things may help cue neutral images, which  
5 would interfere with desire imagery, or they may be interpreted as a tool for suppressing  
6 desire thoughts, which could be counter-productive.

7           Although playing Tetris did not completely suppress craving, decreasing it by  
8 around 24%, this reduction could be sufficient to help people manage their cravings, as  
9 suggested by van Dillen's et al.'s (2013) finding that people were less likely to choose a  
10 high-calorie snack after playing Tetris. Future research could test if manipulating the  
11 duration and difficulty of Tetris can increase its effects on craving. Kemps and  
12 Tiggemann (2013) found a similar 23% reduction in craving intensity when women  
13 watched a visual interference display known to disrupt visual imagery (Andrade, Kemps,  
14 Wernier, May & Szmalec, 2002). Women who were given the opportunity to watch the  
15 display when they craved food reported fewer craving-related thoughts than those in the  
16 control condition who just kept a food diary. We predict that playing Tetris will have  
17 similar benefits for consumption in field settings, particularly because, anecdotally,  
18 participants said they enjoyed playing Tetris, which is important if using it as a take-home  
19 task to help people manage their cravings.

20           Although this study tested an unselected sample of undergraduates, we expect  
21 the findings to generalise to people trying to control their consumption because there is  
22 evidence that other visuospatial tasks are effective when people are motivated to control  
23 rather than indulge their cravings (e.g., Kemps, Tiggemann & Christianson, 2008). In a  
24 comparison of craving phenomenology across different substances, May et al. (2013)

1 found similar mean scores for craving strength across chocolate (mean CEQ-S = 4.40),  
2 cigarettes (4.54), and food (4.68), with the mean for an outpatient sample meeting DSM-  
3 IV-TR criteria for current alcohol dependence being somewhat higher (5.22) but within  
4 the range reported by participants in the present study. Further research would be  
5 needed to examine the effectiveness of Tetris to decrease cravings in a clinical  
6 population.

7         The Craving Experience Questionnaires showed that craving strength and  
8 imagery both decreased more when participants played Tetris than when they watched  
9 the load screen. Craving intrusiveness changed over time but not differentially by  
10 condition. This finding is consistent with EI theory's assumption that elaboration loads  
11 working memory and will be inhibited by concurrent working memory loads, whereas  
12 intrusive thoughts result from automatic, associative processes that are not dependent  
13 on working memory. However, EI theory also predicts that the process of elaboration will  
14 stimulate further intrusive thoughts, so we predict that over longer periods, the effects of  
15 playing Tetris on craving would eventually lead to reductions in intrusions too.

16         In conclusion, we have shown that playing Tetris for a brief period is sufficient to  
17 reduce naturally occurring cravings that participants were already experiencing when  
18 they entered the laboratory. Tetris reduced the vividness and frequency of craving  
19 imagery, as well as craving intensity. This is an important finding for generalising  
20 previous tests of EI theory with induced cravings to naturally occurring cravings for food  
21 and drink, and possibly for addictive substances too, and a step towards developing a  
22 take-home task for helping people to reduce cravings to tolerable levels.

23

24



1 References:

- 2 Andrade, J., Kemps, E., Werniers, Y., May, J. & Szmalec, A. (2002). Insensitivity of  
3 visual short-term memory to irrelevant visual information. *Quarterly Journal of*  
4 *Experimental Psychology A*, 55, 753-774.
- 5 Andrade, J., May, J. & Kavanagh, D. J. (2012). Sensory imagery in craving: From  
6 cognitive psychology to new treatments for addiction. *Journal of Experimental*  
7 *Psychopathology*, 3(2), 127-145.
- 8 Andrade, J., Pears, S., May, J., Kavanagh, D. J. (2012). Use of a clay modeling task to  
9 reduce chocolate craving. *Appetite*, 58 (3), 955–963
- 10 Baddeley, A., & Andrade, J. (2000). Working memory and the vividness of imagery.  
11 *Journal of Experimental Psychology: General*, 129, 126–145
- 12 Burton, S. M., & Tiffany, S. T. (1997). The effect of alcohol consumption on imaginal and  
13 in vivo manipulations of smoking urges. *Addiction*, 92, 15-26
- 14 Caselli, G., Soliani, M. & Spada, M. M. (2013). The effect of desire thinking on craving:  
15 An experimental investigation. *Psychology of Addictive Behaviors*, 27, 301-306
- 16 Erskine, J. A. K. (2008). Resistance can be futile: Investigating behavioural rebound.  
17 *Appetite*, 50, 415-421.
- 18 Gendall, K. A., Joyce, P. R., Sullivan, P. F., & Bulik, C. M. (1998). Food cravers:  
19 Characteristics of those who binge. *International Journal of Eating Disorders*, 23,  
20 353–360

- 1 Green, M. W., Rogers, P. J., & Elliman, N. A. (2000). Dietary restraint and addictive  
2 behaviors: The generalizability of Tiffany's cue reactivity model. *International*  
3 *Journal of Eating Disorders*, 27, 419–427
- 4 Harvey, K., Kemps, E. & Tiggemann, M, (2005). The nature of imagery processes  
5 underlying food cravings. *British Journal of Health Psychology*, 10, 49–56
- 6 Hill, A. J., Weaver, C. F., & Blundell, J. E. (1991). Food craving, dietary restraint and  
7 mood. *Appetite*, 17, 187-197.
- 8 Hofmann, W., Baumeister R., F., Förster, G. & Vohs, K., D. (2011). Everyday  
9 temptations: an experience sampling study of desire, conflict, and self-control.  
10 *Journal of Personality and Social Psychology*, 102, 6, 1318–1335
- 11 Holmes, E. A., James, E. L., Coode-Bate, T., & Deerpse, C. (2009). Can playing the  
12 computer game 'Tetris' reduce the build-up of flashbacks for trauma? A proposal  
13 from cognitive science. *PLoS ONE*, 4, 1.
- 14 Kavanagh, D. J., Andrade, J., & May, J. (2005). Imaginary relish and exquisite torture:  
15 The Elaborated Intrusion theory of desire. *Psychological Review*, 112, 446-467.
- 16 Kavanagh, D., J., May J, Andrade J (2009). Tests of the elaborated intrusion theory of  
17 craving and desire: Features of alcohol craving during treatment for an alcohol  
18 disorder. *British Journal of Clinical Psychology*, 48, 241–254.
- 19 Kemps, E., & Tiggeman, M. (2007). Modality-specific imagery reduces cravings for food:  
20 An application of the Elaborated Intrusion Theory of Desire to food craving.  
21 *Journal of Experimental Psychology: Applied*, 13, 95-104

- 1 Kemps, E. & Tiggemann, M. (2013) Hand-held dynamic visual noise reduces naturally  
2 occurring food cravings and craving-related consumption. *Appetite*, 68, 152-157.
- 3 Kemps, E., Tiggemann, M., & Christianson, R. (2008). Concurrent visuo-spatial  
4 processing reduces food cravings in prescribed weight-loss dieters. *Journal of*  
5 *Behavior Therapy and Experimental Psychiatry*, 39, 177-186.
- 6 Kemps, E., Tiggeman, M., & Hart, G. (2005). Chocolate cravings are susceptible to  
7 visuo-spatial interference. *Eating Behaviours*, 6, 2, 101-107.
- 8 Kemps, E., Tiggemann, M., Woods, D. & Soekov, B. (2004) Reduction of food cravings  
9 through concurrent visuospatial processing. *The International Journal of Eating*  
10 *Disorders*, 36, 1, 31-40
- 11 Knäuper, B., Pillay, R., Lacaille, J., McCollam, A. & Kelso, E. (2011). Replacing craving  
12 imagery with alternative pleasant imagery reduces craving intensity. *Appetite*, 57,  
13 173-178.
- 14 Lafay, L., Thomas, F., Mennen, L., Charles, M. A., Eschwege, E., Borys, J. M. &  
15 Basdevant, A. (2001). Gender differences in the relation between food cravings  
16 and mood in an adult community: Results from the Fleurbaix Laventie Ville Santé  
17 Study, *International Journal of Eating Disorders*, 29,2, 195-204.
- 18 May, J., Andrade, J., Kavanagh, D. J., Feeney, G. F. X., Gullo, M., Statham, D. J.,  
19 Skorka-Brown, J., Connolly, J. M., Cassimatis, M., Young, R. McD., & Connor, J.  
20 P. (2013). The Craving Experience Questionnaire: A brief, theory-based  
21 measure of consummatory desire and craving. *Manuscript in submission*.

- 1 May, J., Andrade, J., Kavanagh, D. J., & Hetherington, M. (2012). Elaborated Intrusion  
2 theory: A cognitive-emotional theory of food craving. *Current Obesity Reports*, 1,  
3 114-121.
- 4 May, J., Andrade, J., Panabokke, N., & Kavanagh, D. (2004). Images of desire: Cognitive  
5 models of craving. *Memory*, 12, 447–461
- 6 May, J., Andrade, J., Panabokke, N., & Kavanagh, D. (2010). Visuospatial tasks  
7 suppress craving for cigarettes. *Behaviour Research And Therapy*, 48(6), 476–  
8 485.
- 9 McClelland, A., Kemps, E. & Tiggemann, M. (2006) Reduction of vividness and  
10 associated craving in personalized food imagery. *Journal of Clinical Psychology*,  
11 62, 3, 355-65.
- 12 Pelchat, M. L. (1997) Food cravings in young and elderly adults, *Appetite*, 28, 2, 103-113
- 13 Schlundt, D. G., Virts, K. L., Sbrocco, T., & Pope-Cordle, J. (1993). A sequential  
14 behavioural analysis of craving sweets in obese women. *Addictive Behaviors*,  
15 18, 67–80
- 16 Sitton, S. C. (1991). Role of craving for carbohydrates upon completion of a protein-  
17 sparing fast. *Psychological Reports*, 69, 683–686
- 18 Statham, D. J., Connor, J. P., Kavanagh, D. J., Feeney, G. F. X., May, J., Andrade, J. &  
19 Young, R. McD. (2011). Measuring alcohol craving: Development of the Alcohol  
20 Craving Questionnaire, *Addiction*, 106, 1230–1238.
- 21 Steel, D., Kemps, E., & Tiggemann, M. (2006). Effects of hunger and visuo-spatial  
22 interference on imagery-induced food cravings. *Appetite*, 46, 36-40

- 1 Stuart, A.D.P., Holmes, E.A. & Brewin, C.R. (2006). The influence of a visuospatial  
2 grounding task on intrusive images of a traumatic film. *Behaviour Research and*  
3 *Therapy, 44*, 611-619
- 4 Van Dillen, L., Nordren, L. & Andrade, J. (2013). Derailing the streetcar named desire:  
5 Cognitive distractions disrupt cravings and unhealthy snacking in response to a  
6 temptation. *Manuscript in submission.*
- 7 Versland, A & Rosenberg, H. (2007). Effect of brief imagery interventions on craving in  
8 college student smokers. *Addiction Research and Theory, 15, 2*, 177-187

1

Condition	N	Craving Before	Craving After	Difference	% change
Load	42	57.90 (21.37)	54.74 (25.04)	3.17 (20.57)	-5.5%
Tetris	38	58.82 (20.61)	44.84 (25.75)	13.97 (19.94)	-23.8%

2

3 Table 1: Means (and Standard Deviations) of scores on the single-item craving measure  
4 before and after the load screen and Tetris conditions

5

Craving factor	Condition	CEQ-S <sub>now</sub>	CEQ-S <sub>then</sub>	CEQ-F <sub>then</sub>
Strength	Load	4.13 (2.20)	3.74 (2.66)	3.27 (2.86)
	Tetris	4.96 (3.00)	2.63 (2.37)	1.76 (1.94)
Imagery	Load	4.14 (2.40)	3.25 (2.81)	3.27 (2.60)
	Tetris	4.88 (2.36)	1.92 (2.25)	1.28 (1.70)
Intrusiveness	Load	3.30 (2.64)	2.43 (2.29)	2.43 (2.53)
	Tetris	3.00 (2.52)	1.58 (2.14)	1.39 (2.17)

1

2 Table 2: Mean craving strength, imagery and intrusiveness reported in the CEQ-S<sub>now</sub>,  
3 CEQ-S<sub>then</sub>, and CEQ-F<sub>then</sub>. (± S.D.)

4