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

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

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

18 157 words

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21 Introduction

22 Although cravings are an everyday occurrence amongst the general population
23 (Lafay et al., 2001) they are linked to a variety of negative effects, even when they are

1 resisted; for example, by causing distress and distraction (Green, Rogers & Elliman,
2 2000). Craving can also be a precursor to binge eating in the general population
3 (Gendall, Joyce, Sullivan & Bulik, 1998), early dropout from weight loss program's
4 (Sitton, 1991), and the development of obesity (Schlundt, Virts, Sbrocco, & Pope-Cordle,
5 1993).

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

19 Visual and auditory imagery load the limited-capacity, modality-specific slave
20 systems of working memory, the visuospatial sketchpad and phonological loop
21 respectively (Baddeley & Andrade, 2000). Involvement of these slave systems in a task
22 can be blocked by irrelevant task loads such a task involving spatial manipulation or
23 visual distraction in the case of the visuospatial sketchpad, or a verbal task in the case of
24 the phonological loop. In support of the EI theory hypothesis that visual imagery is a key
25 component of craving, there is accumulating evidence that visuospatial loads or

1 competing neutral visual images selectively reduce craving, for cigarettes (May,
2 Andrade, Panabokke, & Kavanagh, 2010; Versland & Rosenberg, 2007) and for food
3 (Andrade, Pears, May & Kavanagh, 2012; Harvey, Kemps & Tiggemann, 2005; Kemps
4 & Tiggemann, 2007; Kemps, Tiggemann & Hart, 2005; Kemps, Tiggemann, Woods &
5 Soekov, 2004; McClelland, Kemps and Tiggemann, 2006; Steel, Kemps & Tiggemann,
6 2006).

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

21 We aimed to replicate van Dillen et al's (2013) finding, with an important
22 difference. Previous studies of craving in the laboratory, including those cited above,
23 have induced cravings when participants have come into the laboratory. For example,
24 Andrade, Pears et al (2012) asked participants to inspect and evaluate chocolates; van
25 Dillen et al (2013) asked participants to select items from a menu. The reasoning behind

1 craving inductions is that the novelty and cognitive demand of the laboratory setting may
2 itself reduce cravings, even when participants have abstained from the substance prior to
3 taking part in the study. There is a risk, though, that working memory loads are doing
4 nothing more than removing an artificially induced desire. We therefore recruited an
5 unselected sample and aimed to measure and manipulate any naturally occurring
6 cravings that they were experiencing.

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

18 Van Dillen et al (2013) used behavioural measures of craving, that is, response
19 biases to tempting foods and food choices at the end of the experiment, and a four-item
20 craving scale. We used the Craving Experience Questionnaire (CEQ; Andrade, Pears et
21 al, 2012; May et al, 2013) developed from the Alcohol Craving Experience questionnaire
22 (Kavanagh, May & Andrade, 2009; Statham et al, 2012), to assess craving
23 phenomenology in the control and intervention conditions. The CEQ provides a measure
24 of craving strength, imagery, and intrusiveness. We also asked participants if they were
25 under the influence of alcohol (including being hung-over) to check if this was a

1 confounding variable, because Burton and Tiffany (1997) found that when people had
2 consumed alcohol they had a general increase in craving compared to when they had
3 not.

4

5 Method

6

7 Participants

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

11

12 Design

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

17

18 Materials

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

22 Tetris was played on a 15inch computer monitor with a standard keyboard. The
23 computer game 'Tetris' was downloaded from www.80smusiclyrics.com/games/html

24

1 Participants rated their craving on a single-item scale of 1 (not craving at all) to
2 100 (craving something very much). More detailed information about craving
3 phenomenology was collected using the Craving Experience Questionnaire (CEQ;
4 Andrade, Pears et al, 2012; May et al, 2013), adapted to encompass any sort of craving
5 rather than just craving for chocolate. The CEQ-S_{now} asked participants to rate the
6 strength, imagery vividness, and intrusiveness of their current craving on a scale of 1
7 (not at all) to 11 (extremely). A typical question for assessing craving strength was 'Right
8 now, how strongly do you want [what you are craving]?', for imagery 'Right now, how
9 vividly are you imagining it?', and for intrusiveness 'Right now, how hard are you trying
10 not to think about it?'. This questionnaire provided a snapshot of craving experience
11 immediately before the experimental period began. The CEQ-S_{then} assessed craving
12 experience during the experimental period (load screen or Tetris). It asked the same
13 questions but in relation to the period of time since participants completed the CEQ-S_{now},
14 for example, 'During that time, how vividly were you imagining it?'. The CEQ-F_{then} used
15 similarly phrased questions to ask participants to rate the *frequency* of their cravings,
16 images, and intrusive thoughts since doing the CEQ-S_{now}, on a scale of 1 (not at all) to
17 11 (constantly), for example, 'During that time, how often were you imagining it?'. The
18 'then' versions of the CEQ were used to assess changes in craving experience while
19 participants were playing Tetris, rather than taking a snapshot of craving once the game
20 ended, to avoid contamination by a re-kindling of craving once the interference ended.
21 Andrade, Pears et al (2012) and May et al (2013) reported Cronbach's alpha ratings over
22 0.90 for each scale.

23

24 Procedure:

25

1 The study was approved by the Plymouth University Faculty of Science and
2 Technology Research Ethics Committee. Participants were tested between 9am and
3 4.45pm, to allow for variance in cravings across the day (Hill, Weaver & Blundell, 1991).
4 Participants were also tested in pairs to control for time of day effects, with one person in
5 each pair assigned randomly to each task.

6 After being briefed, participants completed a short questionnaire asking for their
7 demographic information. They were then asked what, if anything, they were craving and
8 completed the CEQ-S_{now} in relation to their craved substance or activity.

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

16 Next, participants completed the CEQ-S_{then} and CEQ-F_{then} to assess their craving
17 experience during the load screen or Tetris period. Finally, they were asked if they were
18 aware of the condition to which they had been assigned. Note that participants who
19 reported not craving anything, still completed all parts of the experiment, answering N/A
20 to craving questions.

21

22

23 Results:

24 A total of 121 participants were tested. Two people reported being aware of their
25 assigned condition and their results were removed from the analysis. Of the 119

1 participants remaining, 80 reported craving something (58 food or drink, 10 caffeine, 12
 2 nicotine) and 39 were not craving anything. Data from participants who reported no
 3 craving are not analyzed further. Hill, Weaver and Blundell (1991) found that cravings
 4 were typically higher in the afternoon compared to other times of day, but a chi-square
 5 analysis found no relationship between time of day and number of participants reporting
 6 craving: $\chi^2(1, N=119) = 0.280, p = 0.299$, therefore time of day is not analyzed further.

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

Task	N	Craving Before	Craving After	Difference	% change from baseline
Load Screen	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%

9

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

12

13 The effect of task on craving was examined using a 2(time) x 2(task condition)
 14 repeated measures ANOVA. Craving reduced over time, $F(1,78) = 14.26, p < 0.001, \eta_p^2 =$
 15 0.16 . The main effect of condition was not significant, $F < 1$, but there was the predicted
 16 interaction between condition and time with greater reduction in craving for the Tetris
 17 condition than for the load screen condition, $F(1,78) = 5.67, p = 0.020, \eta_p^2 = 0.07$. The
 18 interaction remained significant after removing nine participants with weak craving
 19 defined as a score below 20 on the single-item craving scale ($N = 3$) and/or who reported
 20 being under the influence of alcohol ($N = 7$), $F(1,69) = 5.17, p = 0.026, \eta_p^2 = 0.07$, and

1 when only participants' craving food or drink were considered, $F(1,56) = 12.17$, $p =$
 2 0.001 , $\eta_p^2 = 0.18$.

3 To obtain a more detailed picture of craving change, participants' responses on
 4 the CEQ_{now} and CEQ_{then} 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.

7

Craving factor	Condition	CEQ-S _{now}	CEQ-S _{then}	CEQ-F _{then}
Strength	Load	5.13 (2.20)	4.74 (2.66)	4.27 (2.86)
	Tetris	5.96 (3.00)	3.63 (2.37)	2.76 (1.94)
Imagery	Load	5.14 (2.40)	4.25 (2.81)	4.27 (2.60)
	Tetris	5.88 (2.36)	2.92 (2.25)	2.28 (1.70)
Intrusiveness	Load	4.30 (2.64)	3.43 (2.29)	3.43 (2.53)
	Tetris	4.00 (2.52)	2.58 (2.14)	2.39 (2.17)

8 Table 2: Mean craving strength, imagery and intrusiveness reported in the CEQ-S_{now},
 9 CEQ-S_{then}, and CEQ-F_{then}. (\pm S.D.)

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, $F(1,78) = 18.71$, $p < .001$, $\eta_p^2 = 0.19$, and the interaction showed that this reduction
 14 was larger for the Tetris condition, $F(1,78) = 9.60$, $p = 0.003$, $\eta_p^2 = 0.11$. Craving imagery
 15 showed a similar null effect of condition overall, $F < 1$, and reduction over time ($F(1, 78) =$
 16 39.02 , $p < .001$, $\eta_p^2 = 0.33$) and interaction between time and condition ($F(1, 78) = 11.29$,
 17 $p = 0.001$, $\eta_p^2 = 0.13$). Craving intrusiveness also showed no main effect of condition,

1 $F(1,78) = 1.46, p = 0.23, \eta_p^2=0.02$, and a significant reduction over time, $F(1, 78) = 20.73$,
2 $p <.001, \eta_p^2=0.21$, but the interaction did not reach statistical significance, $F(1, 78) =$
3 $1.17, p =0.28, \eta_p^2=0.02$).

4 A one way ANOVA of scores on the CEQ- F_{then} showed that participants
5 experienced less frequent cravings and less frequent craving imagery while playing
6 Tetris than while watching for the load screen, $F(1, 78) = 7.53, p =0.008, \eta_p^2=0.09$, and
7 $F(1, 78) = 15.91, p <.001, \eta_p^2=0.17$ respectively. The frequency of craving-related
8 intrusive thoughts differed in the same direction but the difference fell just short of
9 statistical significance ($F(1, 78) = 3.80, p =0.055, \eta_p^2=0.05$).

10

11 Discussion

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

19 The findings show that studying naturally-occurring cravings, rather than inducing
20 cravings artificially, is a viable option for laboratory research. Around two-thirds of
21 participants reported craving something at the time of completing the experiment and
22 their mean craving levels were reasonably high, around the mid-way point on the
23 baseline single-item craving and CEQ measures. It is possible that our predominately
24 young, female, undergraduate sample experienced stronger cravings than the general
25 population because cravings decrease in strength and frequency with age and women

1 typically experience more cravings than men (Lafay et al, 2001; Pelchat, 1997). In an
2 ecological momentary assessment study of a somewhat broader sample (73% university
3 students), participants reported a current desire on 50% of the sampling occasions and a
4 recent desire on a further 28% of occasions. As in the present study, desires to eat or
5 drink were the most frequently reported (36.7%; Hofmann, Baumeister, Förster, & Vohs,
6 2011). In contrast to previous research (Hill, Weaver and Blundell, 1991), there was no
7 change in craving frequency across the day.

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

20 The findings support the prediction of EI theory that visuospatial tasks weaken
21 cravings via effects on craving imagery, by showing that playing Tetris reduced the
22 vividness and frequency of craving imagery. However, they do not rule out an
23 interpretation that any working memory load would have the same effect, regardless of
24 sensory modality. It remains to be tested whether the effects of Tetris on craving are due
25 specifically to visuo-spatial interference, or to general task demands. Previous research

1 has shown effects of visual tasks over non-visual working memory tasks assumed to
2 impose similar executive processing loads. For example, May et al (2010) reported
3 reductions in cigarette craving when participants imagined neutral visual scenes
4 compared with when they imagined neutral sounds. In the field, Knäuper, Pillay, Lacaille,
5 McCollam, & Kelso (2011) showed that positive visual imagery reduced food cravings
6 over a four-day period compared with reciting the alphabet backwards, a reasonably
7 demanding verbal working memory task. These findings suggest that the visuospatial
8 component of playing Tetris might give benefits over and above those of an equally
9 difficult verbal task, but this prediction has not yet been tested.

10 There is a risk that temporary reductions in craving might lead to later increases.
11 Distraction tasks can increase the 'ironic' effects of thought suppression, leading to
12 behavioural rebound (Erskine, 2008). Although we did not test the long-term impact of
13 playing Tetris, we think it is unlikely to lead to increased craving or consumption in the
14 longer term, for three reasons. First, there is evidence that other visuospatial interference
15 tasks reduce craving and consumption over periods of weeks (Kemps & Tiggemann
16 2013; Knäuper et al, 2011). Second, participants did not receive the thought suppression
17 instructions that are typically associated with rebound effects. Third, Casselli, Soliani and
18 Spada (2013) incidentally included Tetris as a resting phase following manipulations of
19 thought focus in the laboratory. Overall, craving did not increase over the next three
20 days, during which participants continued using their assigned thought focus strategy,
21 suggesting that Tetris did not lead to a rebound. There appeared to be an increase in
22 craving in one 'distraction' condition, where participants focused their thoughts on
23 geographical locations. Casselli et al did not report how often participants used this
24 distraction technique over the three days, or whether they thought about locations
25 associated with their desired activity. Nonetheless, this finding raises the concern that

1 any distraction might lead to increases in craving over time because, as Casselli et al
2 suggest, participants can learn to use it as a thought avoidance strategy. We suggest
3 that the two tasks are rather different, with Casselli's directing people's thoughts to a
4 neutral topic and ours specifically loading the visuospatial working memory processes
5 that people need for elaborating craving images. Future research should test the long-
6 term impact of craving interventions and test whether that impact differs according to the
7 type of distraction employed. Elaborated Intrusion theory predicts that tasks that
8 specifically load working memory processes needed for craving imagery will help break
9 the vicious cycle of desire-related thoughts leading to desire imagery, which leads to
10 more desire thoughts. Predictions about the effects of more general distractions are
11 mixed: Instructions to think about other things may help cue neutral images, which would
12 interfere with desire imagery, or they may be interpreted as a tool for suppressing desire
13 thoughts, which could be counter-productive.

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

1 participants said they enjoyed playing Tetris, which is important if using it as a take-home
2 task to help people manage their cravings.

3 Although this study tested an unselected sample of undergraduates, we expect
4 the findings to generalise to people trying to control their consumption because there is
5 evidence that other visuospatial tasks are effective when people are motivated to control
6 rather than indulge their cravings (e.g., Kemps, Tiggemann & Christianson, 2008). In a
7 comparison of craving phenomenology across different substances, May et al (2013)
8 found similar mean scores for craving strength across chocolate (mean CEQ-S = 4.40),
9 cigarettes (4.54), and food (4.68), with the mean for an outpatient sample meeting DSM-
10 IV-TR criteria for current alcohol dependence being somewhat higher (5.22) but within
11 the range reported by participants in the present study. Further research would be
12 needed to examine the effectiveness of Tetris to decrease cravings in a clinical
13 population.

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

23 In conclusion, we have shown that playing Tetris for a brief period is sufficient to
24 reduce naturally occurring cravings that participants were already experiencing when
25 they entered the laboratory. Tetris reduced the vividness and frequency of craving

1 imagery, as well as craving intensity. This is an important finding for generalising
2 previous tests of EI theory with induced cravings to naturally occurring cravings for food
3 and drink, and possibly for addictive substances too, and a step towards developing a
4 take-home task for helping people to reduce cravings to tolerable levels.

5

6 References:

7 Andrade, J., Kemps, E., Werniers, Y., May, J. & Szmalec, A. (2002). Insensitivity of
8 visual short-term memory to irrelevant visual information. *Quarterly Journal of*
9 *Experimental Psychology A*, 55, 753-774.

10 Andrade, J., May, J. & Kavanagh, D. J. (2012). Sensory imagery in craving: From
11 cognitive psychology to new treatments for addiction. *Journal of Experimental*
12 *Psychopathology*, 3(2), 127-145.

13 Andrade, J., Pears, S., May, J., Kavanagh, D. J. (2012). Use of a clay modeling task to
14 reduce chocolate craving. *Appetite*, 58 (3), 955–963

15 Baddeley, A., & Andrade, J. (2000). Working memory and the vividness of imagery.
16 *Journal of Experimental Psychology: General*, 129, 126–145

17 Burton, S. M., & Tiffany, S. T. (1997). The effect of alcohol consumption on imaginal and
18 in vivo manipulations of smoking urges. *Addiction*, 92, 15-26

19 Caselli, G., Soliani, M. & Spada, M. M. (2013). The effect of desire thinking on craving:
20 An experimental investigation. *Psychology of Addictive Behaviors*, 27, 301-306

21 Erskine, J. A. K. (2008). Resistance can be futile: Investigating behavioural rebound.
22 *Appetite*, 50, 415-421.

- 1 Gendall, K. A., Joyce, P. R., Sullivan, P. F., & Bulik, C. M. (1998). Food cravers:
2 Characteristics of those who binge. *International Journal of Eating Disorders*, *23*,
3 353–360
- 4 Green, M. W., Rogers, P. J., & Elliman, N. A. (2000). Dietary restraint and addictive
5 behaviors: The generalizability of Tiffany's cue reactivity model. *International*
6 *Journal of Eating Disorders*, *27*, 419–427
- 7 Harvey, K., Kemps, E. & Tiggemann, M, (2005). The nature of imagery processes
8 underlying food cravings. *British Journal of Health Psychology*, *10*, 49–56
- 9 Hill, A. J., Weaver, C. F., & Blundell, J. E. (1991). Food craving, dietary restraint and
10 mood. *Appetite*, *17*, 187-197.
- 11 Hofmann, W., Baumeister R., F., Förster, G. & Vohs, K., D. (2011). Everyday
12 temptations: an experience sampling study of desire, conflict, and self-control.
13 *Journal of Personality and Social Psychology*, *102*, 6, 1318–1335
- 14 Holmes, E. A., James, E. L., Coode-Bate, T., & Deerprouse, C. (2009). Can playing the
15 computer game 'Tetris' reduce the build-up of flashbacks for trauma? A proposal
16 from cognitive science. *PLoS ONE*, *4*, 1.
- 17 Kavanagh, D. J., Andrade, J., & May, J. (2005). Imaginary relish and exquisite torture:
18 The Elaborated Intrusion theory of desire. *Psychological Review*, *112*, 446-467.
- 19 Kavanagh, D., J., May J, Andrade J (2009). Tests of the elaborated intrusion theory of
20 craving and desire: Features of alcohol craving during treatment for an alcohol
21 disorder. *British Journal of Clinical Psychology*, *48*, 241–254.

- 1 Kemps, E., & Tiggeman, M. (2007). Modality-specific imagery reduces cravings for food:
2 An application of the Elaborated Intrusion Theory of Desire to food craving.
3 *Journal of Experimental Psychology: Applied*, 13, 95-104
- 4 Kemps, E. & Tiggemann, M. (2013) Hand-held dynamic visual noise reduces naturally
5 occurring food cravings and craving-related consumption. *Appetite*, 68, 152-157.
- 6 Kemps, E., Tiggemann, M., & Christianson, R. (2008). Concurrent visuo-spatial
7 processing reduces food cravings in prescribed weight-loss dieters. *Journal of*
8 *Behavior Therapy and Experimental Psychiatry*, 39, 177-186.
- 9 Kemps, E., Tiggeman, M., & Hart, G. (2005). Chocolate cravings are susceptible to
10 visuo-spatial interference. *Eating Behaviours*, 6, 2, 101-107.
- 11 Kemps, E., Tiggemann, M., Woods, D. & Soekov, B. (2004) Reduction of food cravings
12 through concurrent visuospatial processing. *The International Journal of Eating*
13 *Disorders*, 36, 1, 31-40
- 14 Knäuper, B., Pillay, R., Lacaille, J., McCollam, A. & Kelso, E. (2011). Replacing craving
15 imagery with alternative pleasant imagery reduces craving intensity. *Appetite*, 57,
16 173-178.
- 17 Lafay, L., Thomas, F., Mennen, L., Charles, M. A., Eschwege, E., Borys, J. M. &
18 Basdevant, A. (2001). Gender differences in the relation between food cravings
19 and mood in an adult community: Results from the Fleurbaix Laventie Ville Santé
20 Study, *International Journal of Eating Disorders*, 29,2, 195-204.
- 21 May, J., Andrade, J., Kavanagh, D. J., Feeney, G. F. X., Gullo, M., Statham, D. J.,
22 Skorka-Brown, J., Connolly, J. M., Cassimatis, M., Young, R. McD., & Connor, J.

- 1 P. (2013). The Craving Experience Questionnaire: A brief, theory-based
2 measure of consummatory desire and craving. *Manuscript in submission*.
- 3 May, J., Andrade, J., Kavanagh, D. J., & Hetherington, M. (2012). Elaborated Intrusion
4 theory: A cognitive-emotional theory of food craving. *Current Obesity Reports*, *1*,
5 114-121.
- 6 May, J., Andrade, J., Panabokke, N., & Kavanagh, D. (2004). Images of desire: Cognitive
7 models of craving. *Memory*, *12*, 447–461
- 8 May J, Andrade J, Panabokke N, Kavanagh D (2010). Visuospatial tasks suppress
9 craving for cigarettes. *Behaviour Research And Therapy*, *48*(6), 476–485.
- 10 McClelland, A., Kemps, E. & Tiggemann, M. (2006) Reduction of vividness and
11 associated craving in personalized food imagery. *Journal of Clinical Psychology*,
12 *62*, 3, 355-65.
- 13 Pelchat, M. L. (1997) Food cravings in young and elderly adults, *Appetite*, *28*, 2, 103-113
- 14 Schlundt, D. G., Virts, K. L., Sbrocco, T., & Pope-Cordle, J. (1993). A sequential
15 behavioural analysis of craving sweets in obese women. *Addictive Behaviors*,
16 *18*, 67–80
- 17 Sitton, S. C. (1991). Role of craving for carbohydrates upon completion of a protein-
18 sparing fast. *Psychological Reports*, *69*, 683–686
- 19 Statham, D. J., Connor, J. P., Kavanagh, D. J., Feeney, G. F. X., May, J., Andrade, J. &
20 Young, R. McD. (2011). Measuring alcohol craving: Development of the Alcohol
21 Craving Questionnaire, *Addiction*, *106*, 1230–1238.

- 1 Steel, D., Kemps, E., & Tiggemann, M. (2006). Effects of hunger and visuo-spatial
2 interference on imagery-induced food cravings. *Appetite*, 46, 36-40
- 3 Stuart, A.D.P., Holmes, E.A. & Brewin, C.R. (2006). The influence of a visuospatial
4 grounding task on intrusive images of a traumatic film. *Behaviour Research and*
5 *Therapy*, 44, 611-619
- 6 Van Dillen, L., Nordren, L. & Andrade, J. (2013). Derailing the streetcar named desire:
7 Cognitive distractions disrupt cravings and unhealthy snacking in response to a
8 temptation. *Manuscript in submission*.
- 9 Versland, A & Rosenberg, H. (2007). Effect of brief imagery interventions on craving in
10 college student smokers. *Addiction Research and Theory*, 15, 2, 177-187

11