Elsevier Editorial System(tm) for Appetite
Manuscript Draft

Manuscript Number: APPETITE-D-10-00034R2

Title: Less Food for Thought: Impact of Attentional Instructions on Intrusive Thoughts about Snack Foods

Article Type: Full length paper

Keywords: Craving; Imagery; Mindfulness; Acceptance; Body Scan; Breath Focus; Intervention; Obesity

Corresponding Author: Professor Jon May,

Corresponding Author's Institution: University of Plymouth

First Author: Jon May, PhD

Order of Authors: Jon May, PhD; Jackie Andrade, PhD; Helen Batey, MSc; Lisa-Marie Berry, PhD; David J Kavanagh, PhD

Abstract: Intrusive thoughts about food may play a role in unhealthy eating behaviours. Food-related thoughts that capture attention can lead to craving and further intrusive thoughts (Kavanagh, Andrade & May, 2005). We tested whether diverting attention to mental images or bodily sensations would reduce the incidence of intrusive thoughts about snack foods. In two experiments, participants reported their thoughts in response to probes during three 10-minute periods. In the Baseline and Post-task period, participants were asked to let their mind wander. In the middle, Experimental, period, participants followed mind-wandering (control), thought diversion, or thought suppression instructions. Self-directed or guided imagery, mindfulness-based body scanning, and thought suppression all reduced the proportion of thoughts about food, compared to Baseline. Following body scanning and thought suppression, food thoughts returned to baseline frequencies post-task, rather than rebounding. There were no effects of the interventions upon craving, although overall, craving and thought frequency were correlated. Thought control tasks may help people to ignore thoughts about food and thereby reduce their temptation to snack.

Cover Letter

This version of the manuscript includes the changes agreed in our email correspondence.

Response to Reviewers

This version of the manuscript includes the following changes agreed in our email correspondence.

P12, line 5. 'Linear time' for 'intrusive thoughts at Post-task'

P13, line 16 'mean craving was not elevated at the end of the experimental task' for 'mean craving did not rise immediately after the experimental task'

P14, line 4: 'at the end of' for 'during'

P14 line 6: '(relative to Baseline)' inserted

P14 line 7: 'at the end of' for 'following'

P18: Text changed to:

'There was a significant interaction of Condition with Quadratic time $F(2, 46) = 5.31$, $p = .008$, $\eta^2 = .187$, but as in Experiment 1, the Linear time contrast showed that there was no differential rebound above Baseline in intrusive thoughts $F(2, 46) = 1.91$, $p = .16$, $\eta^2 = .076$. Inspection of Figure 3 suggests that the reduction in intrusive thoughts during the tasks was restricted to the Body Scan and Guided Imagery conditions, and that there was a Post-task rebound above Baseline for Guided Imagery, but not for the Body Scan condition. Separate ANOVAs with factor of Time within each condition confirmed these effects for Body Scan ($F(2,32)=9.53$, $p = .001$, $\eta^2 = .37$; Quadratic time $F(1,16)=25.2$, $p<.001$, $\eta^2 = .61$, Linear time $F<1$) and Guided Imagery ($F(2,30)=9.71$, $p = .001$, $\eta^2 = .39$; Quadratic time $F(1,15)=15.3$, $p = .001$ $\eta^2 = .51$, Linear time $F(1,16) = 4.87$, $p = .043$, $\eta^2 = .25$). There were no effects of Time for the Control condition (all $F<1$).

As in Experiment 1, there were differences in Baseline food thoughts between the conditions, so an ANCOVA was conducted with Baseline food thoughts as a covariate'…

P23 '2010' for 'under review'

P28 '476-485' added to May, J., Andrade, J., Panabokke, N., & Kavanagh, D. (2010) reference.

Less Food for Thought:

Impact of Attentional Instructions on Intrusive Thoughts about Snack Foods

Jon May

Jackie Andrade

Helen Batey

School of Psychology, University of Plymouth, UK

Lisa-Marie Berry

Department of Psychology, University of Sheffield, UK

David J. Kavanagh

Institute of Health & Biomedical Innovation and School of Psychology & Counselling,

Queensland University of Technology, Australia

Address for correspondence:

Prof Jon May,

School of Psychology,

University of Plymouth,

Drake Circus,

Plymouth PL4 8AA, UK

Email jon.may@plymouth.ac.uk

DRAFT: PLEASE ASK BEFORE CITING OR CIRCULATING

REVISION 21.06.2010

Acknowledgements

This work was supported by the Economic and Social Research Council [grant numbers RES-000-22-1562 and PTS-030-2005-00484]. We would like to thank Mark J.G. Williams and Judith Soulsby for their help in developing the thought monitoring scripts used in experiment 2.

Abstract

Intrusive thoughts about food may play a role in unhealthy eating behaviours. Food-related thoughts that capture attention can lead to craving and further intrusive thoughts (Kavanagh, Andrade & May, 2005). We tested whether diverting attention to mental images or bodily sensations would reduce the incidence of intrusive thoughts about snack foods. In two experiments, participants reported their thoughts in response to probes during three 10-minute periods. In the Baseline and Post-task period, participants were asked to let their mind wander. In the middle, Experimental, period, participants followed mind-wandering (control), thought diversion, or thought suppression instructions. Self-directed or guided imagery, mindfulness-based body scanning, and thought suppression all reduced the proportion of thoughts about food, compared to Baseline. Following body scanning and thought suppression, food thoughts returned to baseline frequencies post-task, rather than rebounding. There were no effects of the interventions upon craving, although overall, craving and thought frequency were correlated. Thought control tasks may help people to ignore thoughts about food and thereby reduce their temptation to snack.

[167 words]

Key words: Craving, Imagery, Mindfulness, Acceptance, Body Scan, Breath Focus, Intervention, Obesity

Introduction

Intrusive thoughts about food have an important role in maintaining dysfunctional eating behaviours, primarily by triggering craving (McManus & Waller, 1995), and act as a proximal trigger for lapses when people are trying to restrict intake (Loewenstein, 1996). Food cravings have been shown to lead to episodes of binge-eating (Gendall, Joyce, Sullivan & Bulik, 1998), to predict dropout from weight-loss programs (Sitton, 1991), and have been linked to obesity (Schlundt, Virts, Sbrocco & Pope-Cordle, 1993). Even if intense desires to eat are resisted, they induce discomfort and distress, and divert attention from other cognitive tasks (Green, Rogers & Elliman, 2000). Self-report data suggest that the phenomenology of craving for food is similar to craving for addictive drugs; craving across a range of addictive and everyday substances involves intrusive thoughts and mental images of consumption (Kavanagh, May & Andrade, 2009; May, Andrade, Kavanagh & Penfound, 2008; May, Andrade, Panabokke & Kavanagh, 2004). Understanding the cognitive and emotional processes that generate these craving thoughts and images should allow more effective techniques to be developed to attenuate cravings, helping people to refrain from consuming substances they are trying to avoid.

The Elaborated Intrusion theory of desire (EI theory; Kavanagh, Andrade & May, 2005) describes craving as an episode of imagery-based cognitive elaboration that follows an intrusive thought about a target. Physiological deficit, negative affect, external cues, other cognitive activity, and anticipatory responses to the target can all trigger associative processes that occur beneath awareness and that result in an apparently spontaneous target-related thought, where the 'target' is the desired substance or activity. This intrusive thought marks the beginning of the craving episode for the individual, since it is the first thought that they are aware of. In EI theory, intrusions can prompt elaboration: conscious, controlled processing that involves the internal and external search for target-related information, and

the retention and elaboration of this information in working memory, which serves to further maintain the craving episode.

Self-report data from questionnaire studies support the idea that sudden, intrusive thoughts and vivid sensory images are important features of craving (Kavanagh *et al*., 2009; May *et al*., 2004; 2008). Recent research suggests that disrupting craving imagery, with competing neutral imagery tasks, reduces subjective craving levels in abstaining smokers (Pannabokke, 2004; Versland & Rosenberg, 2007), dieters (Kemps, Tiggemann, Woods & Soekov, 2004) and undergraduates induced to crave food or chocolate (Kemps & Tiggemann, 2007). However, little research has specifically focused on intrusive thoughts in craving. According to EI theory, intrusive thoughts do not automatically trigger elaborative craving. Rather, the subsequent elaboration depends upon the salience of the intrusion relative to competing task demands and goals. Even in a sample of people seeking treatment for alcohol dependency, 87% of respondents sometimes experienced momentary intrusive thoughts about alcohol that vanished spontaneously without elaboration (Kavanagh *et al*., 2009). Interventions that focus on preventing an elaborative response to the initial target-related intrusion, therefore, offer the potential to prevent full-blown craving episodes developing. The present study explores such interventions, some based upon mindfulness, or acceptance-based, approaches.

Mindfulness-based therapies, which incorporate thought control techniques such as breath focus and body scanning, teach individuals to notice and accept unwanted thoughts as just thoughts, without entering into cycles of negative appraisal or rumination (Kabat-Zinn, 2003). Mindfulness to the person's continually changing sensory experience is also likely to increase the salience of other thoughts which may compete with the negative thoughts (e.g. cognitive associations or sensory awareness of other events or internal states). Beneficial effects have been claimed for mindfulness-based therapies in a wide range of conditions in

which intrusive thoughts are typical, including depression, generalized anxiety disorder, psychosis, and grieving (Teasdale *et al*., 2000; Orsillo, Roemer & Barlow, 2003; Sagula & Rice, 2004; Watkins & Teasdale, 2004). In substance misuse, mindfulness-based interventions have been shown to reduce relapse, possibly by allowing people to alter the relationship that they have with the difficult cognitions that act as triggers to their cravings, and by enabling people to recognize and monitor cravings as they occur (Breslin *et al*., 2002; Marlatt, 2002). Recently, Ussher, Cropley, Playle, *et al*. (2009) found that listening to a body scanning or an isometric exercise instruction tape reduced desire to smoke, compared to a control group who had listened to a reading about natural history.

In contrast to mindful acceptance, a common alternative way to deal with unwanted intrusive thoughts is to try to suppress them: the intent of thought suppression is to prevent unwanted thoughts from occurring at all rather than on one's response to them. Evidence is mixed on whether this exacerbates the problem or is an effective strategy. Some studies suggest that suppression has the ironic effect of increasing intrusive thoughts, either when undertaking the suppression (Lavy & van den Hout, 1990) or afterwards (Wegner, Schneider, Carter & White, 1987; Wegner & Erskine, 2003), because in order to check that one is not thinking of something, one has to think about it – this has been called the 'ironic effect' of thought suppression (Wegner, Erber & Zanakos, 1993). Indeed, it has been argued that repeated suppression of unwanted thoughts can have such a negative effect as to be a causal and maintenance factor in much mental illness (Hayes *et al*., 1996): for example, promoting depressive rumination (Wenzlaff & Luxton, 2003) and exacerbating symptoms in anxiety and obsessive-compulsive disorder (Becker *et al*., 1998; Purdon 2004). Negative effects of suppression can also be seen in some studies on craving. In Kavanagh *et al*. (2009), the more frequently participants had tried to suppress alcohol-related thoughts, the more alcohol thoughts they had. Greater attempts to suppress alcohol-related thoughts were associated with

stronger craving and a more extended craving episode. In Salkovskis and Reynolds (1994), participants who were in a thought suppression condition had more intrusive thoughts during and after the task, than did those in a thought-monitoring condition.

However, suppression of thoughts is not always counter-productive. Suppression often has no effect on personally-relevant or emotional thoughts (Kelly & Kahn, 1994; Muris, Merckelbach, van den Hout, & de Jong, 1992; Wegner and Gold, 1995) and can result in short-term reductions in thoughts, provided there is no concurrent task to capture attentional resources (Wegner, 1989). Nosen & Woody (2009) found that a tendency to suppress unwanted thoughts was not a factor in predicting the success of quit smoking attempts. Furthermore, if the person responds to suppression instructions by ignoring the thought and thinking about other things, or relinquishes efforts to monitor the occurrence of the target thought, there is no theoretical reason why suppression should not work. Using a specific, unrelated thought for distraction reduces the rebound effect (Wegner *et al*., 1987) and instructing people to ignore, rather than suppress, thoughts about snack foods reduces consumption (Achtziger, Gollwitzer & Sheeran, 2008).

We therefore included a thought suppression condition in which participants were asked to divert their thoughts to imagery of a particular self-relevant activity. We focused on the use of imagery, since as already noted, competing imagery reduces craving for a range of appetitive targets (Kemps & Tiggemann, 2007; Kemps *et al*., 2004; Pannabokke, 2004; Versland & Rosenberg, 2007). Interfering with food imagery through competing imagery tasks should break the cycle of cognitive elaboration of the desire, which otherwise leads to further thoughts about the appetitive target.

Experiment 1

Experiment 1 compared a mindfulness based approach to unwanted food thoughts (Breath Focus) against two natural responses which either emphasise not having the thoughts

at all (Thought Suppression) or diverting attention away from them when they do occur (Imagery Diversion). We also included a Control condition with no requirement to suppress or avoid thoughts about food, to serve as a baseline measure of food thought occurrence in the absence of control instructions. The instructions are given in Appendix 1, and it should be noted that all conditions mention that 'your mind may wander to think about snack foods', and that the imagery diversion and thought suppression instructions include an explicit requirement to stop thinking such thoughts, whereas the breath focus and control instructions do not. Snack foods were mentioned in all of the instructions to equate the conditions in terms of cueing (Wenzlaff & Wegner, 2000). While mentioning the thought topic does lead to the possibility of a spurious increase above natural rates of occurrence, it is consistent across conditions.

Breath focus was selected as a technique that should be readily understood and employed by participants in the short timeframe of the experiment. A 15-minute dose of breath focus has been shown to reduce emotional responses to negative stimuli (Arch & Craske, 2006), and the 'body scan' tape shown to reduce desire to smoke in Ussher *et al*. (2009) consisted mainly of breath and abdominal focus instructions. Effects were tested over three 10-min periods: at Baseline, during or immediately after the tasks (Experimental), and in a post-task period (Post). We predicted that the breath focus and imagery diversion instructions would result in fewer food related thoughts during the task than the control instruction. Given the mixed literature on attempts to replicate the ironic effect of thought suppression increasing personally-relevant thoughts, we tentatively predicted that the thought suppression instruction would increase intrusive thoughts during or after the task. We also expected that a reduction in intrusive thoughts would be associated with a less intense craving.

Method

48 Undergraduates (39 female, 9 male; mean age 21 years 10 months) at The University of Sheffield who were attempting to cut down on snack foods, took part in the experiment in exchange for £10 payment. The experiment was governed by the ethical procedures of the British Psychological Society and the American Psychological Association, and was approved by the University of Sheffield Department of Psychology Ethics Committee. Participants were recruited via an online advertisement on the University website, accessible to those within the university. On responding, participants were emailed a questionnaire consisting of the White Bear Suppression Inventory (WBSI, Wegner, 1989) and the Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003). Scores on these scales were used to check that participants were matched on habitual thought suppression and dispositional mindfulness across the four experimental conditions.

Participants were asked to abstain from eating for two hours before coming in to the lab, to minimise the chance of people taking part while satiated. Testing sessions lasted an hour in total, and were carried out throughout the day, starting between 9.30 am and 4.15pm. On arrival, they gave signed informed consent and completed an Eating Attitudes Test (EAT-26 factor 1; Garner *et al*., 1982) designed to highlight 'abnormal' thoughts about food. Participants scoring more than 20 on the EAT were excluded to screen out those with an eating disorder. They then completed a biographical questionnaire, containing demographic information and five items about eating habits, intended to increase the salience of hunger and food.

Three thought-monitoring periods (12 minute Baseline, 10 minute Experimental, 10 minute Post-task) were undertaken. During each period, a bell sounded several times, and participants were instructed to report in one or two words what they were thinking the moment before the bell sounded. Responses were transcribed by the experimenter, and at the

end of the experiment, participants were shown the transcripts and asked to identify any thoughts relating to food or eating. This thought sampling method, developed by Teasdale, Lloyd, Proctor, & Baddeley (1993) has become the most commonly used method for investigating mind wandering (Smallwood & Schooler, 2006), because it requires minimal interpretation or disruption at the point of sampling, and allows participants to classify their own thought content at a later point without having to give detail about the thoughts. The first two minutes of the Baseline period included four bells, and was treated as a practice with the thought monitoring procedure and responses were not analysed (although this was not apparent to participants). Initially ten bell probes were used in the remaining ten minutes (for each period), at intervals of between 45-90 seconds. After 20 participants had taken part, the number of bell probes was increased to 20 (at intervals of 15-45 seconds) to increase the sensitivity of the thought monitoring and to help participants focus upon the task (the monitoring period being otherwise unfilled). Because of differences in the number of reporting intervals over the course of data collection, percentage of food-related thoughts was used in analyses.

Immediately after the end of each thought monitoring period, participants' craving was assessed. Participants were presented with a 100mm line, and asked to: "Please place a mark on the line to indicate the intensity of your current craving for snack food" (with anchors of no craving at all, to extreme craving).

During the first (Baseline) and third (Post) periods, all participants received control instructions to think about anything at all, and that it was OK to think about snack foods. The *Control* participants also received these instructions during the second (Experimental) period, but the other participants received either Breath Focus, Thought Suppression or Imagery Diversion instructions (Appendix 1).

Results

Participant characteristics

Of the 48 participants, 11 were in the Control condition, 12 in Breath Focus, 12 in Thought Suppression and 13 in Imagery Diversion conditions. Time of testing was not associated with any of the dependent variables (max $|r| = .19$, $p = .189$). There were no significant differences between conditions for Gender ($\chi^2(3) = 1.66$, $p = .65$.), Age ($F(3, 43) = 2.13$, $p = .11$, $\eta^2 = .129$), or in WBSI (M=49.7, SD=11.7), MAAS (M=57.0, SD=11.3) or EAT (M=6.2, SD=4.5), all Fs < 1. Nor were there differences in Baseline intrusive thoughts $F(3, 44) = 1.73$, $p = .17$, $\eta^2 = .106$, or Baseline craving $F(3, 44) = 1.44$, $p = .25$, $\eta^2 = .089$.

The mean proportion of intrusive thoughts about food at Baseline was 30% (SD = 18%), with only two participants reporting no intrusive thoughts about food. Craving at Baseline was relatively low, with 35% scoring less than 30 on the 0-100 single-item scale (M = 40.7, SD = 24.1).

Intrusive thoughts during the session

An independent t test showed that the number of probes (10 or 20) had no effect upon the percentage of thoughts that were related to food in any of the three blocks (max $t(46) = 1.1$, $p = .277$).

A repeated measures ANOVA with the factors of Time (Baseline, Experimental and Post) and experimental Condition showed a main effect of Time ($F(2,88) = 6.48$, $p = .002$, $\eta^2 = .13$) and an interaction of Time with Condition ($F(2,88) = 2.60$, $p = .023$, $\eta^2 = .15$), but no main effect of Condition ($F(3,44) = 1.76$, $p = .17$, $\eta^2 = .11$). Two polynomial contrasts were conducted on the Time effects: a Quadratic contrast to compare the Experimental period against Baseline and Post-task periods; and a Linear contrast to compare Baseline against Post-task. There were significant main effects for Quadratic time ($F(1, 44) = 7.76$, $p = .008$,

η^2 = .150), reflecting a drop during the experimental tasks, and Linear time (F(1, 44) = 4.46, p = .04, η^2 = .092), reflecting a rise in intrusive thoughts from Baseline to Post-task. There was a significant interaction of Condition with Quadratic time (F(3, 44) = 3.58, p = .021, η^2 = .196), but no interaction of Condition with Linear time (F(3, 44) = 1.05, p = .38, η^2 = .067). Inspection of Figure 1 shows that the reduction in food-related intrusions during the task was primarily due to responses of participants in the Imagery Diversion and Thought Suppression conditions. Separate ANOVAs conducted within each Condition confirmed effects of Time in the Imagery Diversion (main effect F (2,24) = 7.32, p = .003, η^2 = .38; Quadratic contrast F(1,12)=14.8, p = .002, η^2 = .55) and Suppression (F(2,22) = 4.52, p = .023, η^2 = .29; Quadratic contrast F(1,11)=4.95, p = .048, η^2 = .31) conditions, but not in the Breath Focus (F(2,22) = 2.25, p = .13, η^2 = .17) or Control (F<1) conditions.

Although there were no significant differences at Baseline, an ANCOVA with baseline food thoughts as a covariate was conducted, with the factors of Time (Experimental v Post-task) and Condition. There were no effects of Time (F<1) or Condition F(3,43) = 1.77, p = .167, η^2 = .11, but the interaction was significant F(3,43)=3.09, p = .037, η^2 = .18. Further oneway ANCOVAs were conducted upon the Experimental and Post-task experimental periods separately, with Baseline intrusive thoughts as a covariate, in order to conduct contrasts of the three experimental conditions against the Control condition. For the Experimental period, there was an effect of Condition (F(3,43) = 4.22, p = .011, η^2 = .23), with significant differences between the Control condition and the Imagery Diversion (p = .004) and Thought Suppression conditions (p = .050), but not the Breath Focus condition (p = .714). There was no main effect of Condition for the Post experimental period (F(3,43)<1), and none of the conditions differed from the Control (max p = .171).

This pattern of effects indicates that the Imagery Diversion and Thought Suppression instructions successfully reduced food thoughts without resulting in any rebound (although it

should be noted that by splitting the sample up in this way, these comparisons lack statistical power: with 12 participants and a sample standard deviation of 20%, an increase in intrusive thoughts of 10% would be detected 53.5% of the time).

Craving during the session

A repeated measures ANOVA with the factors of Time (Baseline, Experimental and Post-task) and experimental Condition showed a main effect of Time $F(2,88) = 9.62$, $p < .001$, $\eta^2 = .18$, and an interaction of Time with Condition $F(2,88) = 2.57$, $p = .024$, $\eta^2 = .15$, but not of Condition ($F<1$). Overall, there was a significant rise in craving over the experiment (Linear time: $F(1, 44) = 16.11$, $p < .001$, $\eta^2 = .268$), but no main effect for Quadratic time $F(1, 44) = 0.95$, $p = .34$, $\eta^2 = .021$. There was no interaction of Condition with Linear time in craving over the experiment between conditions $F(3, 44) = 1.90$, $p = .14$, $\eta^2 = .115$, but as in the analysis of intrusive thoughts, there was a significant interaction of Condition with Quadratic time $F(3, 344) = 3.48$, $p = .024$, $\eta^2 = .19$. Figure 2 shows that Thought Suppression was the only condition in which mean craving was not elevated at the end of the experimental task. Separate ANOVAs within condition showed effects of Time within the Breath Focus $F(2,22)=7.88$, $p = .003$, $\eta^2 = .42$, Imagery Diversion $F(2,24) = 3.77$, $p = .038$, $\eta^2 = .24$ and Control $F(2,20) = 7.14$, $p = .005$, $\eta^2 = .42$, but not in the Thought Suppression condition $F(2,22)=1.33$, $p = .285$, $\eta^2 = .11$.

As for the intrusive thoughts, separate ANCOVAs were conducted for the Experimental and Post-task periods, with baseline craving as a covariate, in order to conduct contrasts between the experimental conditions and the control instruction. There was an effect of Condition after the Experimental period $F(3,43)=3.23$, $p = .032$, $\eta^2 = 18$, with the Thought Suppression condition differing from the Control ($p = .016$), but the Imagery Diversion ($p = .104$) and Breath Focus ($p = .978$) conditions did not differ from the Control. After the

Post-task period, there was no main effect of Condition $F(3,43)=1.01$, $p = .398$, $\eta^2 = .07$, and none of the conditions differed significantly from the Control (min $p = .224$).

Overall, these effects indicate that craving rose at the end of the Experimental period for all conditions except Thought Suppression, where it fell - but Thought Suppression did not show a rebound effect (relative to Baseline) Post-task.

Craving intensity at the end of each period was positively correlated with intrusive thought frequency during that period (Baseline: $r = .458$, $p = .001$; Experimental: $r = .450$, $p = .001$; Post-task: $r = .391$, $p = .003$). These relationships remained even if the preceding craving intensity was controlled for (Experimental, controlling for Baseline craving : $r = .41$, $p = .002$; Post-task, controlling for Experimental craving: $r = .41$, $p = .002$).

Discussion

Results of Experiment 1 were only partially consistent with our expectations. Firstly, while Imagery Diversion produced the expected reduction in intrusive thoughts during the task, it did not have an effect on craving. Indeed, craving rose throughout the experiment. We were puzzled by this result, and wanted to see if the effect was replicable.

Secondly, Thought Suppression was the only condition that contributed both to the reduction of intrusive thoughts about food during the task, and of craving intensity immediately after it. Furthermore, it produced no post-task rebound above Baseline levels of food-related thoughts or craving. These effects were not consistent with those of Salkovskis and Reynolds (1994) or Kavanagh *et al*. (2009), but potentially were consistent with those of Achtziger *et al*. (2008). In that study, participants were asked to ignore thoughts rather than to suppress them – thought acceptance being the key difference between mindfulness and suppression. An alternative explanation, which was in fact mentioned by some participants in their comments on the task, is that participants spontaneously responded to food thoughts by focusing on alternate thoughts, confounding our intended thought suppression condition with

the imagery diversion condition. Given the different interpretations some participants put on instructions to suppress thoughts, we considered that a second experiment should concentrate on positive attentional focus instructions, rather than on what participants should try to avoid thinking of.

Finally, we had expected that Breath Focus might reduce intrusive thoughts and craving intensity by drawing attention to competing thoughts and sensations, but it had neither effect. Breath focus is a very commonly used mindfulness meditation for people who are inexperienced, as it is one of the easiest to undertake (Kabat-Zinn, 1990). The regularity of breathing helps to focus attention, and the explicit focus on attending to abdominal breathing may also release muscular tension. However, directing participants' attention to their abdomen, which our instructions explicitly did, may also have drawn attention to any physiological hunger sensations (e.g., borborygmi). A more general attentional focus on the body may be needed to affect intrusions about snack foods or related craving. A body scan provides such a general focus, and retains the link with meditation and mindfulness-based strategies (Segal, Williams & Teasdale, 2002). The isometric exercise tape found to reduce desire to smoke by Ussher *et al*. (2009) was analogous to a true body scan, since it focuses attention on the physical sensations from the body, albeit during active movement rather than passive sitting.

Experiment 2

The second experiment tested the effects of a Body Scan instruction against those from Guided Imagery and Control instructions, in a between-subjects design. The three periods used in Experiment 1 were retained (Baseline, Experimental, Post-task), but some participants had reported that these periods – unfilled apart from the occasional thought probe – were too long for them to focus on the task. To increase confidence that participants were engaging in the instructed attentional focus throughout the experimental period, we played

them audio recordings containing an instructional statement every 20 seconds. The repeated guidance about what to think about, coupled with the absence of a condition involving explicit thought suppression instructions, meant that we did not need to include any mention of food related thoughts, or the need to avoid them, or stop them, unlike Experiment 1.

The Baseline, Control condition, and Post-task instruction tapes each comprised 30 instructions asking participant to let their mind wander freely, and lasted ten minutes. For each tape, a set of 10 sentences was read three times, in different orders (the three tapes thus contained the same statements, but in a different order). In Body Scan, 30 sentences instructed participants to move the focus of their attention from their toes, upward through their body to the top of their head. Special reference was made to sensations associated with breathing, but no mention was made of the abdomen or stomach. Positive affective adjectives were also avoided, as was any mention of relaxation or tension (in order to avoid suggestions associated with positive mood). Guided Imagery also involved 30 sentences, asking the participant to imagine a walk through a wood, including sight, sounds, smells and physical sensations. Positive affective adjectives were avoided, as was any mention of relaxation or danger. The statements used in each recording are listed in Appendix 2.

As in Experiment 1, thought probes were given by the sound of a bell ringing during the intervals between statements in each tape. Ten probes were used, at the same points in each of the Body Scan, Guided Imagery and Control tapes, and at different points in the Baseline and Post tape. The bells occurred at varying intervals after the end of each sentence, giving participants between 7 and 12 seconds to respond before the next sentence began.

Method

49 undergraduates from the University of Sheffield (18 male, 31 female; mean age 20 years 11 months) were recruited via an online advertisement on the University website, accessible to those within the university, and offering £10 payment in exchange for

participation. None had taken part in Experiment 1. On responding to the advertisement, they were sent MAAS, WBSI and EAT forms to complete via email. As in Experiment 1, participants had to score less than 20 on the EAT. They were not required to be actively cutting down on snack foods, although ten in each condition (59-63%) reported they were currently trying to diet. The experiment was governed by the ethical procedures of the British Psychological Society and the American Psychological Association, and was approved by the University of Sheffield Department of Psychology Ethics Committee. Participants gave signed informed consent before taking part in the laboratory component of the study. On arrival at the laboratory, the procedure was similar to that in Experiment 1, including the 'biographical' set on questions intended to raise awareness of food and hunger, with the exception that no mention was made of having or controlling food related thoughts until after the final tape, when the experimenter showed the participant the transcriptions of their responses to the thought probes, and asked them to classify them as food related or not.

Results

Participant characteristics

Of the 49 participants, there were 16 Controls, 17 in Body Scan, and 16 in Guided Imagery conditions. There were no significant differences between the experimental conditions for Gender ($\chi^2(2) = 4.22$, $p = .12$), Age (M=20.9, SD=4.7) , WBSI (M=44.8, SD=8.9), MAAS (M=60.9, SD=11.4), EAT (M=6.3, SD = 4.5), Baseline intrusive thoughts (M = 23%, SD = 19%) or Baseline craving (M = 42.4, SD = 26.8), all $F<1$.

Only two participants had no intrusive thoughts about snacks at Baseline, but the proportion of intrusive thoughts was slightly lower than in Experiment 1. The distribution of Baseline craving scores was almost identical to Study 1, with 35% scoring less than 30 on the 0-100 Craving scale at Baseline. Preliminary analyses on potentially confounding variables (including whether or not participants were currently dieting) did not show any effects.

Intrusive thoughts during the session

A repeated measures ANOVA with the factors of Time (Baseline, Experimental and Post-task) and experimental Condition showed a main effect of Time $F(2,92) = 11.30$, $p < .001$, $\eta^2 = .20$, and an interaction of Time with Condition $F(2,92) = 3.28$, $p = .015$, $\eta^2 = .13$, but not of condition ($F<1$).There was a significant main effect for Quadratic time $F(1, 46) = 27.1$, $p < .001$, $\eta^2 = .370$ — i.e. a reduction in thoughts during the tasks, but no main effect for Linear time $F(1, 46) = 0.62$, $p = .43$, $\eta^2 = .013$. There was a significant interaction of Condition with Quadratic time $F(2, 46) = 5.31$, $p = .008$, $\eta^2 = .187$, but as in Experiment 1, the Linear time contrast showed that there was no differential rebound above Baseline in intrusive thoughts $F(2, 46) = 1.91$, $p = .16$, $\eta^2 = .076$. Inspection of Figure 3 suggests that the reduction in intrusive thoughts during the tasks was restricted to the Body Scan and Guided Imagery conditions, and that there was a Post-task rebound above Baseline for Guided Imagery, but not for the Body Scan condition. Separate ANOVAs with factor of Time within each condition confirmed these effects for Body Scan ($F(2,32)=9.53$, $p = .001$, $\eta^2 = .37$; Quadratic time $F(1,16)=25.2$, $p<.001$, $\eta^2 = .61$, Linear time $F<1$) and Guided Imagery ($F(2,30)=9.71$, $p = .001$, $\eta^2 = .39$; Quadratic time $F(1,15)=15.3$, $p = .001$ $\eta^2 = .51$, Linear time $F(1,16) = 4.87$, $p = .043$, $\eta^2 = .25$). There were no effects of Time for the Control condition (all $F<1$).

As in Experiment 1, there were differences in Baseline food thoughts between the conditions, so an ANCOVA was conducted with Baseline food thoughts as a covariate, and there was a main effect of Time $F(1,45) = 9.13$, $p = .004$, $\eta^2 = .17$ and an interaction with Condition $F(2,45) = 7.78$, $p = .003$, $\eta^2 = .23$, but no main effect of Condition ($F<1$). Separate oneway ANCOVAs were then conducted on the Experimental and Post-task periods with the Baseline period as a covariate, to enable contrasts on the conditions to be carried out. There was a significant effect of Condition during the Experimental period ($F(2,25) = 3.25$,

p = .048, η^2 = .13), with Body Scan differing from Control (p = .015), but Guided Imagery did not differ from Control (p = .145). During the Post-task period, there was no effect of Condition (F(2,45)=1.73, p = .189, η^2 = .07), and while Body Scan did not differ from Control (p = .417), there was a marginal difference for Guided Imagery (p = .070). This pattern of effects indicates that, compared to the Control, and taking Baseline levels of food thoughts into account, Body Scanning reduced food thoughts without leading to a rebound, whereas Guided Imagery did not reduce food thoughts significantly, but did create a trend towards a rebound.

Craving during the session

A repeated measures ANOVA with the factors of Time (Baseline, Experimental and Post-task) and experimental Condition showed no main effect of Time F(2,92) = 2,24, p = .11, η^2 = .05, or Condition, nor an Interaction (Fs<1).There were no significant Time effects (Quadratic: F(1, 46) = 1.72, p = .196, η^2 = .036; Linear: F(1, 46) = 2.53, p = .119, η^2 = .052), or Condition x Time interactions (Quadratic: F(1, 46) = 0.24, p = .782, η^2 = .011; Linear: F(1, 46) = 1.01, p = .374, η^2 = .042) for craving in the full sample. To test if this was because some participants had very low Baseline craving, and so could not show any reduction in response to the interventions, we undertook a secondary analysis with the 32 participants initially scoring over 30. Now, there was a marginal main effect of Time F(2,58) = 2.89, p = .064, η^2 = .09, and a significant Quadratic main effect for Time F(1, 29) = 8.57, p = .007, η^2 = .228, but no significant Linear effect of Time, or interactions with Condition (all Fs<1).

The ANCOVA with baseline craving as covariate showed a marginal effect for Time F(1,45) = 3.36, p = .074, η^2 = .07, but no effect of Condition (F<1) or interaction F(2,45) = 1.19, p = .313, η^2 = .05. Excluding the low scoring participants led to a significant effect for Time F(1,28) =6.15, p = .019, η^2 = .18, but no effect of Condition or interaction

$F(2,28) = 1.72$, $p = .198$, $\eta^2 = .11$. Separate oneway ANCOVAs on the Experimental and Post-task experimental periods with Baseline craving as a covariate showed no main effects of Condition (both $Fs < 1$), and no differences between the Control and either experimental conditions (min $p = .194$). This remained the case even if the low Baseline participants were excluded. Overall, this indicates a trend for craving to increase during the experiment, unmediated by condition.

As in Experiment 1, craving intensity following each period was positively correlated with Intrusive thought frequency during that period (Baseline $r = .33$, $p = .010$; Experimental $r = .32$, $p = .012$; Post r=.26, $p = .037$). The relationships between the Experimental measures remained when the Baseline rating of craving intensity was controlled for ($r = .264$, $p = .035$), but the Post-task relationship did not remain when the Experimental rating of craving intensity was controlled for ($r = .12$, $p = .200$).

Discussion

Experiment 2 showed that when a body focus was moved from an abdominal one to one that scanned the whole body, this mindfulness-inspired instruction did reduce food related thoughts, without leading to a post-task rebound. The apparent reduction in food thoughts during the Guided Imagery was not statistically significant (due to a lower Baseline level in this condition), but the rebound effect almost was – here the low power of the experiment is problematic. Craving immediately after the experimental task was again moderately correlated with the number of intrusive thoughts during the task, but was not differentially affected by Body Scanning or Guided Imagery. Relatively low Baseline craving levels may have contributed to the lack of clear results on craving, here and in Experiment 1, but excluding low-scoring participants did not produce clearer results (and further reduced power to detect effects).

General Discussion

Three interventions – body scanning, thought suppression, and imagery diversion – reduced the incidence of intrusive thoughts about food. The mindfulness-based intervention of breath focus did not reduce intrusions about food, possibly because increased attentional focus on the abdomen offset potential beneficial effects of distraction. The findings support arguments that we can harness the general clinical benefits of thought control to reduce the intrusive thoughts that help motivate unhealthy behaviours, including over-eating and addictions (Breslin *et al*., 2002; Marlatt, 2002), and are consistent with the findings of Ussher *et al*. (2009). The body scanning results also give hope that simple meditation-based elements of mindfulness can be effective on their own as interventions for intrusions, making them promising candidates as self-help tools for people trying to reduce unwanted thoughts during attempts to diet or quit smoking (in fact, the instructional recordings used by Ussher *et al*. can be downloaded as MP3 files from the NHS site http://smokefree.nhs.uk).

The positive effects of Thought Suppression at first sight conflict with the literature. The standard, ironic effect of thought suppression is to immediately increase the incidence of to-be-suppressed thoughts or to cause a rebound in those thoughts, relative to baseline, once the suppression attempt ceases (Wegner, 1989). Some research with personally-relevant or emotional thoughts also suggests that suppression is counter-productive (Salkovskis & Reynolds, 1994; Zeitlin, Netten & Hodder, 1995). However, other research suggest a somewhat different picture: some studies find no effect from suppression (e.g., Erskine, 2008; Wegner & Gold, 1995), while others report that suppression is successful (Kelly & Kahn, 1994, Experiment 1; Levy & Anderson, 2002). The present findings show that people are able to suppress personally-relevant and frequently experienced thoughts over short periods. As suggested in the Discussion to Experiment 1, one reason for discrepant results on suppression may be that participants may engage in thought monitoring during the tasks to a different

extent. Instructions that coupled thought suppression with self-relevant imagery had a similar pattern of effects to thought suppression alone, while in Experiment 2 the Guided Imagery condition without an suppression instruction was less successful. This suggests that our Thought Suppression participants in Experiment 1 might have been implicitly diverting their thoughts rather than just suppressing them.

The general finding of a relationship between habitual thought suppression and psychological disorders (e.g. Rassin, Merckelbach & Muris, 2000) may partly be due to secondary distress over the thought's occurrence, leading to consciously directed thought monitoring, thereby accentuating any ironic effects of attempted suppression. We suggest that there may be situations where thought suppression coupled with diversion may be a useful strategy. However, we recommend caution until these hypotheses have been further investigated.

Thought suppression was the only intervention to show an effect on craving as well as intrusions. Elaborated Intrusion (EI) theory predicts a close relationship between intrusive thoughts and craving, with intrusions being a conscious stimulus for the cycle of affectively-charged cognitive elaboration that we call craving (Kavanagh *et al*., 2005), but intrusive thoughts and elaborated images are seen by the theory as distinct mental entities. Intrusive thoughts are not always elaborated. Even in an addicted sample, most people experienced some thoughts about consumption that popped into mind and then went again (Kavanagh *et al*., 2009); elaboration of intrusions would be expected to happen less often in samples with relatively low Baseline craving, as in this study. Another reason for a weak relationship between intrusions and craving in the present study is the difference in the way the two phenomena were measured, with intrusive thoughts being probed throughout the measurement period and a single-item measurement of craving made at the end. Some intrusive thoughts may be highly salient and elicit substantial momentary craving (due to their

content and to their repeated previous elicitation during periods of high-intensity craving). If so, it may only take one of these thoughts to occur shortly before the end of the task, for immediate post-task craving to be high: Little association with the frequency of tasks during the previous 10 minutes would then be seen. To test this hypothesis, more fine-grained analysis of thoughts during experimental tasks is required, along with measurement or retrospective estimation of frequency, duration and of craving throughout the experimental period.

Reliance on a single rating of momentary craving may also explain the lack of effect of the imagery interventions on craving. This null result might seem surprising, given numerous reports of visual imagery or visuospatial working memory tasks reducing craving for food and other substances (Kemps & Tiggemann, 2007; Kemps, Tiggemann & Hart, 2005; Kemps, Tiggemann, Woods & Soekov, 2004; May, Andrade, Panabokke & Kavanagh, 2010; McClelland, Kemps & Tiggemann, 2006; Steel, Kemps & Tiggemann, 2006; Versland & Rosenberg, 2007). A key difference is the timescale used in those studies. Kemps typically asked people to retain an image of food for 8 seconds and then rate craving for that food. Versland and Rosenberg asked participants to rate how strongly they had been craving just before they finished a 2-minute experimental phase, and we asked for craving ratings during the intervention phase (May *et al*., 2010, Experiments 1 and 2; see also Kemps & Tiggemann, 2007) or after 2-minute interventions (Experiments 3 and 4). Therefore, in previous studies, craving assessment was much more closely tied to the intervention than in the present study, where craving was only rated once at the end of a 10-minute intervention period. However, it is difficult to think of a way in which we could have asked participants to rate their craving during the thought monitoring periods, without inducing food related thoughts.

The two experiments reported in this paper were conducted upon samples drawn from a predominantly young, mainly female, undergraduate population. Although we recruited

people who felt they were 'trying to cut down on snack foods' in Experiment 1, there was no direct measure of this nor of any problems with weight control, although we did exclude participants with abnormally high scores on the Eating Attitudes Test. As such, the findings need extending to different populations, especially those who are on restricted diets or other weight control programmes where snacking between meals may be a more serious problem. We did not find any time of day effects in Experiment 1, but this was not a formal part of the design and it would also be useful to compare the effects at different times of day, or in response to situations containing food cues.

We argue that the results of the current studies have important implications, even if subsequent research were to confirm that effects are not carried over to the intensity of subsequent craving. First, reducing intrusions is important because people may often act on intrusive thoughts before the craving they trigger becomes very intense or aversive, an effect that limits the ability of craving intensity to predict subsequent behaviour (e.g., Tiffany 1990; Weiss, Griffin & Hufford, 1995). Intrusive thoughts may particularly drive behaviour in this way when they are perceived as interrupting one's concentration on another task and when there is little incentive to refrain from indulging one's desires. So, if we got a niggling thought about chocolate while writing a paper, and were not trying to lose weight, we might eat some chocolate so we could concentrate on the paper, uninterrupted by further intrusions. If we were dieting, then we might abstain until an intrusion is elaborated into an intense craving before acting upon it. The cognitive drivers of behaviour may differ, depending on the relative salience of such long-term and short-term goals. Interventions to reduce the impact of intrusive thoughts may influence behaviour more in the former case, where behaviour is impulsively triggered by thoughts, than in the second where cognitive elaboration intervenes between the thought and behaviour.

Second, the frequency of intrusive thoughts is likely to increase the chance that elaborative craving is elicited, and to extend the duration of acute episodes of craving (Kavanagh *et al*., 2005). We therefore predict that relationships between intrusions and craving, and effects of the interventions used in this study on craving, would be stronger over a longer time period where there was greater opportunity for cravings to develop.

Third, if a person is distressed by the occurrence of intrusive thoughts or by their inability to completely eliminate them, this is likely to undermine both their self-efficacy and ability to control problematic behaviour and undertake other tasks (Kavanagh & Bower, 1985). Interventions targeting intrusive thoughts therefore hold the potential to reduce consumption, reduce distress and maximise functional attainments. Thought suppression and attention distraction interventions were both effective but, given the potential problems highlighted by other authors in long-term use of thought suppression, we recommend directing attention to mental images or bodily sensations as the more promising avenue for future research into treatments for intrusive thoughts.

References

Achtziger, A., Peter M. Gollwitzer, P. M. & Sheeran, P. (2008). Implementation intentions and shielding goal striving from unwanted thoughts and feelings. *Personality and Social Psychology Bulletin, 34*, 381-393.

Arch, J.J. & Craske, M.G. (2006) Mechanisms of mindfulness: Emotion regulation following a focused breathing induction. *Behaviour Research and Therapy, 44*, 1849-1858.

Becker, E.S., Rinck, M., Roth, W.T., & Margraf, J. (1998). Don't worry and beware of white bears: Thought suppression in anxiety patients. *Journal of Anxiety Disorders, 12,* 39-55.

Breslin, F.C., Zack, M. & McMain, S. (2002) An Information-Processing Analysis of Mindfulness: Implications for Relapse Prevention in the Treatment of Substance Abuse *Clinical Psychology: Science and Practice 9* (*3)*, 275–299

Brown, K.W., & Ryan, R.M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84,* 822-848.

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

Garner, D. M, Olmsted, M. P., Bohr, Y., & Garfinkel, P. E. (1982) The Eating Attitudes Test: psychometric features and clinical correlates. *Psychological Medicine 12*, 871-8.

Gendall, K. A., Joyce, P. R., Sullivan, P. F., & Bulik, C. M. (1998). Food cravers: Characteristics of those who binge. *International Journal of Eating Disorders, 23,* 353–360

Green, M.W., Rogers, P.J., & Elliman, N.A. (2000) Dietary restraint and addictive behaviors: The generalizability of Tiffany's cue reactivity model. *International Journal of Eating Disorders, 27*, 419-427.

Hayes, S. C., Wilson, K. G., Gifford. E. V., Follette, V. M., & Strosahl, K. D. (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of Consulting and Clinical Psychology, 64*, 1152-1168.

Kabat-Zinn J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10,* 144-156.

Kavanagh, D., Andrade, J., & May, J. (2005) The imaginary relish: a cognitive- emotional account of craving. *Psychological Review, 112*, 446-467.

Kavanagh, D. J., & Bower, G. H. (1985). Mood and self-efficacy: Impact of joy and sadness on perceived capabilities. *Cognitive Therapy and Research, 9*, 507-525.

Kavanagh, D. J., May, J., & Andrade, J. (2009). Tests of the Elaborated Intrusion Theory of craving and desire: Features of alcohol craving during treatment for an alcohol disorder. *British Journal of Clinical Psychology, 48,* 241–254.

Kelly, A.E., & Kahn, J.H. (1994). Effects of suppression of personal intrusive thoughts. *Journal of Personality and Social Psychology, 66,* 998-1006.

Kemps, E. & Tiggemann, M., (2007). Modality-specific imagery reduces cravings for food: An application of the Elaborated Intrusion theory of desire to food craving. *Journal of Experimental Psychology: Applied, 13*(2), 95-104.

Kemps, E., Tiggemann, M., & Hart, G. (2005). Chocolate cravings are susceptible to visuo-spatial interference. *Eating Behaviors, 6,* 101–107.

Kemps, E., Tiggemann M., Woods, D., & Soekov, B. (2004). Reduction of food cravings through concurrent visuo-spatial processing. *International Journal of Eating Disorders, 36*, 31– 40.

Lavy, E.H., & van den Hout, M.A. (1990). Thought suppression induces intrusions. *Behavioural Psychotherapy, 18,* 251-258.

Levy, B.J. & Anderson, M.C. (2002) Inhibitory processes and the control of memory retrieval. *Trends in Cognitive Science, 6*(*7),* 299-305.

Loewenstein, G. (1996). Out of control: Visceral influences on behavior. *Organizational Behavior and Human Decision Processes*, *65*, 272-292.

Marlatt, G.A. (2002). Buddhist philosophy and the treatment of addictive behaviour. *Cognitive and Behavioral Practice, 9,* 44-50.

May, J., Andrade, J., Kavanagh, D., & Penfound, L. (2008). Imagery and strength of craving for eating, drinking and playing sport, *Cognition and Emotion, 22*(4), 633-650.

May, J., Andrade, J, Panabokke, N. & Kavanagh, D. (2004). Images of desire: Cognitive models of craving, *Memory*, *12*(4), 447-461.

May, J., Andrade, J., Panabokke, N., & Kavanagh, D. (2010). Visual imagery tasks suppress craving for cigarettes. *Behaviour Research and Therapy, 48,* 476-485.

McClelland, A., Kemps, E., & Tiggemann, M. (2006) Reduction of vividness and associated craving in personalized food imagery. *Journal of Clinical Psychology, 62*(*3), 355-365.*

McManus, F., & Waller, G. (1995). A functional analysis of binge-eating. *Clinical psychology review, 15,* 845-863.

Muris, P., Merckelbach, H., van den Hout, M. & de Jong, P. (1992). Suppression of emotional and neutral material. *Behaviour Research and Therapy, 30*, 639–642.

Nosen, E., & Woody, S.R. (2009) Applying Lessons Learned from Obsessions: Metacognitive Processes in Smoking Cessation. *Cognitive Therapy and Research, 33*, 241-254

Orsillo, S.M., Roemer, L., Barlow, D.H. (2003) Integrating acceptance and mindfulness into existing cognitive-behavioral treatment for GAD: A case study. *Cognitive and Behavioral Practice, 10*(*3),* 222-230.

Pannabokke, N. (2004) *The Role of Visual Imagery in Craving.* Unpublished PhD dissertation, University of Sheffield.

Purdon, C. (2004). Empirical investigations of thought suppression in OCD. *Journal of Behaviour Therapy and Experimental Psychiatry, 35*(*2)* 121-136.

Rassin, E., Merckelbach, H., & Muris, P. (2000). Paradoxical and less paradoxical effects of thought suppression: A critical review. *Clinical Psychology Review, 20,* 973-995.

Sagula, D. & Rice, K.G. (2004) The effectiveness of mindfulness training on the grieving process and emotional well-being of chronic pain patients. *Journal of Clinical Psychology in Medical Settings, 11*(*4)*, 333-342.

Salkovskis, P.M., & Reynolds, M. (1994). Thought suppression and smoking cessation. *Behaviour Research and Therapy, 32,* 193-201.

Schlundt, D. G., Virts, K. L., Sbrocco, T., & Pope-Cordle, J. (1993). A sequential behavioural analysis of craving sweets in obese women. *Addictive Behaviors, 18,* 67–80.

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). *Mindfulness-based cognitive therapy for depression.: A new approach to preventing relapse.* New York: Guilford.

Sitton, S. C. (1991). Role of craving for carbohydrates upon completion of a protein-sparing fast. *Psychological Reports, 69*, 683–686.

Smallwood, J. & Schooler, J.W., (2006) The restless mind. *Psychological Bulletin*, *132*, 946–958.

Steel, D., Kemps, E., & Tiggemann, M. (2006) Effects of hunger and visuo-spatial interference on imagery-induced food cravings. *Appetite, 46, 36-40.*

Teasdale, J. D., Lloyd, C. A., Proctor, L., & Baddeley, A. (1993). Working memory and stimulus-independent-thought: Effects of memory load and presentation rate. *European Journal of Psychology, 5,* 417–433

Teasdale, J.D., Segal, Z.V., Williams, J.M.G., Ridgeway, V.A., Soulsby, J.M., & Lau, M.A. (2000). Prevention of relapse-recurrence in major depression by Mindfulness-Based Cognitive Therapy. *Journal of Consulting and Clinical Psychology, 68,* 615-623.

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic processes. *Psychological Review, 97,* 147–168.

Ussher, M., Cropley, M., Playle, S., Mohidin, R., & West, R. (2009) Effect of isometric exercise and body scanning on cigarette cravings and withdrawal symptoms. *Addiction, 104,* 1251-1257.

Versland, M. & Rosenberg, H. (2007) Effects of brief imagery interventions on craving in college student smokers. *Addiction Research and Theory, 15*(2), 177-187.

Watkins, E.R., & Teasdale, J.D. (2004) Adaptive and maladaptive self-focus in depression. *Journal of Affective Disorders, 82,* 1-8.

Wegner, D.M. (1989). *White bears and other unwanted thoughts.* New York: Viking/Penguin.

Wegner, D.M., Erber, R., & Zanakos, S. (1993) Ironic processes in the mental control of mood and memory-related thought. *Journal of Personality and Social Psychology, 65,* 1093-1104.

Wegner, D. M., & Erskine, J. (2003). Voluntary involuntariness: Thought suppression and the regulation of the experience of will. *Consciousness and Cognition, 12*, 684-694

Wegner , D. M., & Gold, D.B. (1995) Fanning Old Flames: Emotional and Cognitive Effects of Suppressing Thoughts of a Past Relationship. *Journal of Personality and Social Psychology, 68*(*5)*, 782-792.

Wegner, D. M., Schneider, D. J., Carter, S., & White, T. (1987). Paradoxical effects of thought suppression. *Journal of Personality and Social Psychology, 53,* 5-13.

Weiss, D., Griffin, M. L., & Hufford, C. (1995). Craving in hospitalized cocaine abusers as a predictor of outcome. *American Journal of Drug and Alcohol Abuse, 21*, 289–301.

Wenzlaff, R.M. & Wegner, D.M. (2000) Thought suppression. *Annual Review of Psychology, 51,* 59-91.

Zeitlin, Netten and Hodder (1995). Thought suppression: An experimental investigation of spider phobics. *Behaviour Research and Therapy, 33,* 407-413

Appendix 1: Experiment 1 Instructions

Control

Let your mind wander wherever it would like to, let your attention drift. There is no need to control your thoughts in any way, just let them wander. You may find that your mind wanders to thoughts about snack food. If you do think about snack food, that's OK. I'd like you to think about whatever you like. Thoughts are not right or wrong. Just let your attention drift.

Breath Focus

Focussing your attention on the experience of your breathing, see if it is possible to be aware of the changing patterns of physical sensation in the lower abdomen, as the breath moves in and out of your body. There is no need to control the breathing in any way, simply using the breath to anchor you in the present moment... You may find that your mind wanders away from the focus on the breath, maybe even to thoughts about snack food. If this happens you may find that it helps to imagine your mind as being like a vast, clear sky. Imagining your thoughts about snack food as clouds, moving across it, along with your other thoughts, at varying speeds and shapes and sizes. The sky remaining, the clouds coming and going.

Thought Suppression

Let your mind wander wherever it would like to, let your attention drift. There is no need to control your thoughts in any way, just let them wander. You may find that your mind wanders to thoughts about snack food. If this happens, I'd like you to get rid of the thought as quickly as possible and try to make sure it does not return. It is really important that you try as hard as you can to suppress all thoughts about snack food and banish them from your mind, so that you do not think about them at all.

Imagery Diversion

Focus your attention on your chosen activity, {*activity*}. Imagine yourself carrying out the activity, as vividly as possible. Imagine the scene, sounds, etc, as you mentally perform this activity. You may find that your mind wanders, maybe even to thoughts about snack food. If this happens, I'd like you to bring your attention back to focus on your chosen activity, rather than snack foods. Again imagine the scene, sounds, etc, of this activity as vividly as possible.

Appendix 2: Experiment 2 Instructions

Body Scan

Sitting in your chair feet flat on the floor and hands resting in your lap / Focussing on your breathing, feeling how the air moves in and out of your body / Noticing how the breath feels as it moves through your nose or mouth / Now directing your attention to the toes of your feet / <bell 72s> / Tuning into sensations in your toes, noticing how they feel / Noticing whatever sensations are here, right now / Now on an out breath, letting go of the toes, moving your focus to the bottom of your feet, the soles, and heel / Staying here, paying attention to any sensations you find / <bell 153s> / Now on an out breath moving your attention to your ankles, noticing what sensations are present / Next, moving the focus of your attention into your legs, and knees, noticing how they feel / Now moving your attention up into your thighs and bottom, noticing the pressure of the chair supporting you / <bell 209s> / And now moving your attention up into your hips, and lower back, noticing any sensations present / Now moving up into your chest and upper back, noticing the sensations of movement as you breath in and out / <bell 251s> / Noticing again how each breath feels, not trying to control your breathing, simply paying attention / Noticing the air flowing through you, filling your chest and emptying out again / And now, on an out breath, moving awareness up into your shoulders and neck / Now moving your attention down into your upper and then lower arms / <bell 330s> / Next, on an out breath, letting go of your arms and moving down into your hands / Seeing how they feel, as they rest in your lap / <bell 368s> / Moving awareness up now, paying particular attention to your face / Moving your attention into your nostrils, noticing the air pass in and out as you breathe / Noticing also any sensations in your lips and jaw and inside your mouth / Now moving your attention to your cheeks and your eyes / <bell 448s> / Exploring next the sensations in your forehead, your ears and across your scalp / Finally, focussing on the very top of your head, the uppermost part of your body / <bell 490s> / And now coming back to your breathing / Noticing your breath flowing in and out / <bell 528s> / Imagining the breath flowing all of the way into your body, into the tips of your fingers, and right down into your toes / Imagining your breath flowing up and down your body as you breath naturally / <bell 571s> / Now bringing your attention back to the air in your nostrils, the rise and fall of your chest / And when you feel ready opening your eyes and once again taking in the room

Guided Imagery

I want you to imagine that you are walking along the edge of a field towards a small wood just ahead of you / The sun is out and the air is bright and fresh / You walk into the wood along a narrow path between the trees / The wood is composed of many kinds of trees / <bell 72s> / The trees extend their leafy branches down to the earth / The branches of the trees wave towards you / Brightly coloured birds call from the wood, their voices rising and fading / Thousands of shades of green moss carpet the ground beneath the trees / <bell 153s> / Sunlight plays with the leaves and casts shadows on the path / You can smell the damp earth and can see a haze of blue in the distance / You feel the twigs breaking under your feet / <bell 209s> / Look up to see bits of the blue, blue sky through the tops of the trees / Catch glimpses of birds as they fly from one tree to the next / <bell 251s> / In front of you a winding path leads uphill through the tees / Feel the path beneath your feet as you travel through the wood / The trees become denser and the air becomes cooler / It becomes darker as the trees grow closer together / <bell 330s> / You can see blue sky through the trees / All around you are bluebells, bobbing their heads in the breeze / <bell 368s> / the scent of the bluebells wafts around you / ahead of you is a large log that has fallen and settled in the middle of the wood / you sit on the log and look around you at the wood / run your hand along the branch, feeling the contours of the rough, old bark / <bell 448s> / the woodland creatures are going about their daily business, unaware of your presence / a robin comes close and you can see the red of his chest / <bell 490s> / further away you see beetles and ants scurrying along / the branches of the trees make strange shapes against the sky / <bell 528s> / There are sounds of bird song and the breeze in the tree branches / You can hear a stream running past somewhere nearby / <bell 571s> / the sounds of the wood are all around you / and when you feel ready, opening your eyes and once again taking in the room

Control statements:

The three control tapes consisted of three repetitions of each of the following ten statements, in three differently ordered blocks, with ten thought-probe bells.
Following any thought that comes along / Just watching thoughts drift through your mind / Thinking about anything your mind wants to / Let your mind wander wherever it will go / Thinking about anything or nothing at all / Letting any thoughts come and go / Following the thoughts wherever they take you / Letting your mind wander freely / Let any thought come into your head / Letting your mind go where it wants.

Figure 1. Experiment 1: Percentage of thoughts about food reported during ten minute thought monitoring blocks (bars: 1 SE)

Figure 2. Experiment 1: Intensity of craving rated at end of ten minute thought monitoring blocks (bars: 1 SE)

Figure 3. Experiment 2: Percentage of thoughts about food reported during ten minute thought monitoring blocks (bars: 1 SE)

Figure 4. Experiment 2: Intensity of craving rated at end of ten minute thought monitoring blocks (bars: 1 SE)

Figure 1.

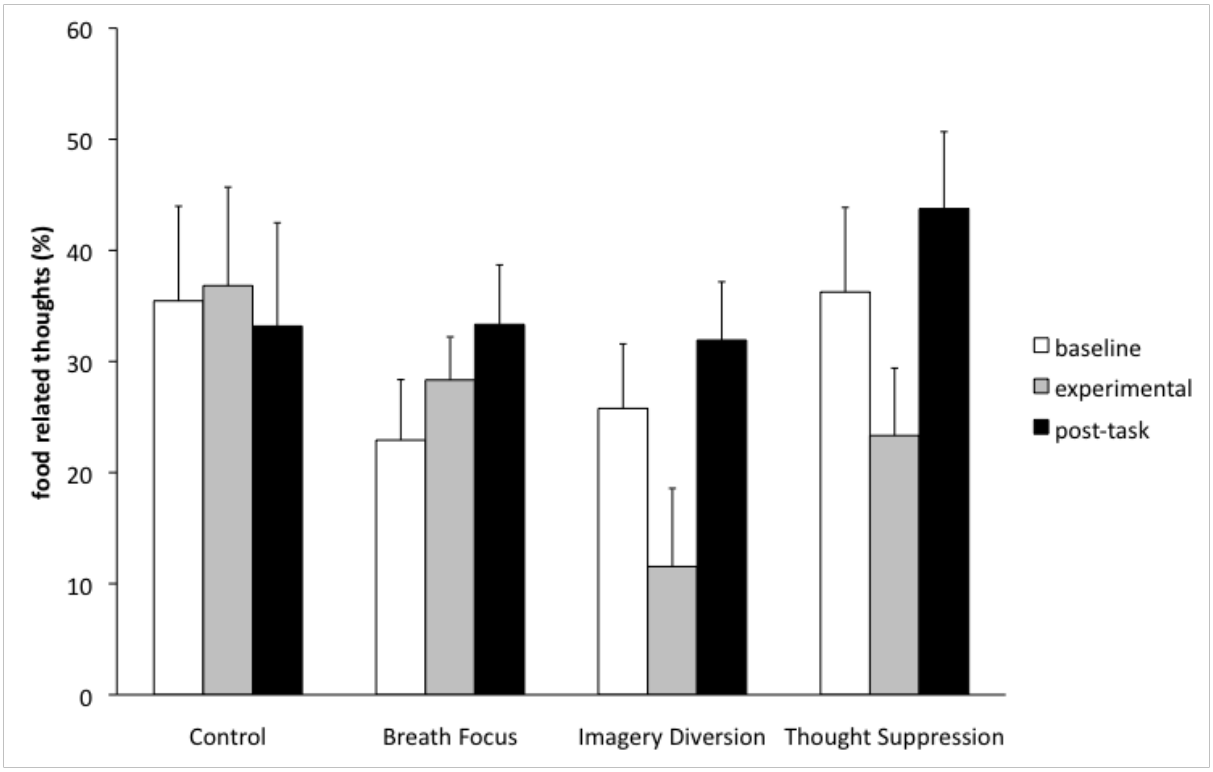

60
50
40
30
20
10
0
food related thoughts (%)
Control
Breath Focus
Imagery Diversion
Thought Suppression
baseline
experimental
post-task

Figure 2

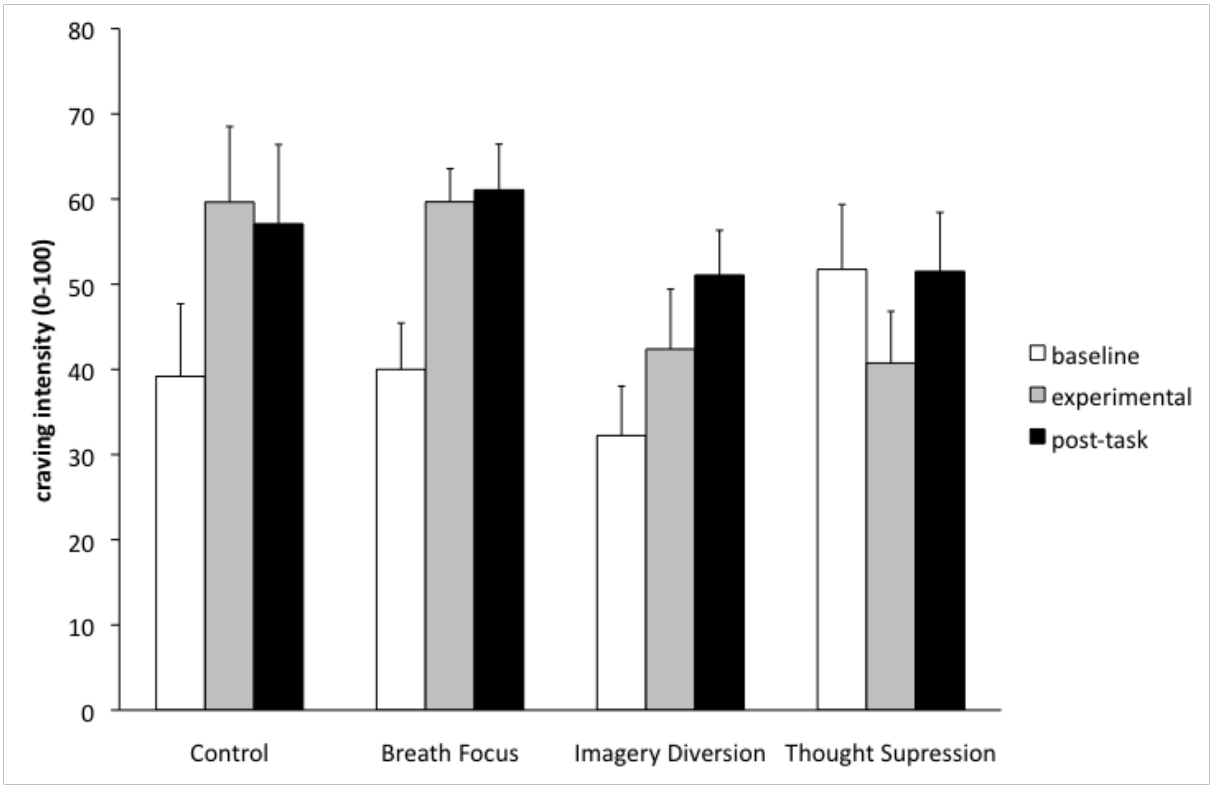

craving intensity (0-100)
80
70
60
50
40
30
20
10
0
Control
Breath Focus
Imagery Diversion
Thought Supression
baseline
experimental
post-task

Figure 3

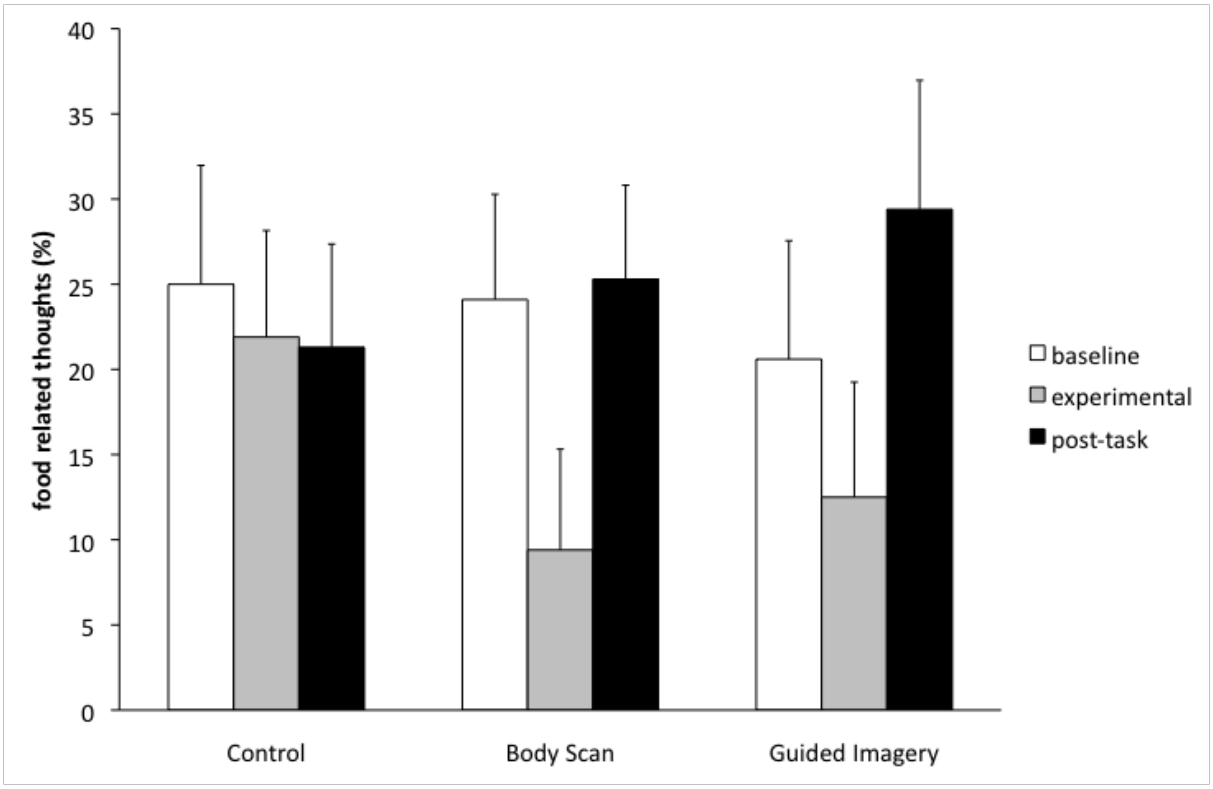
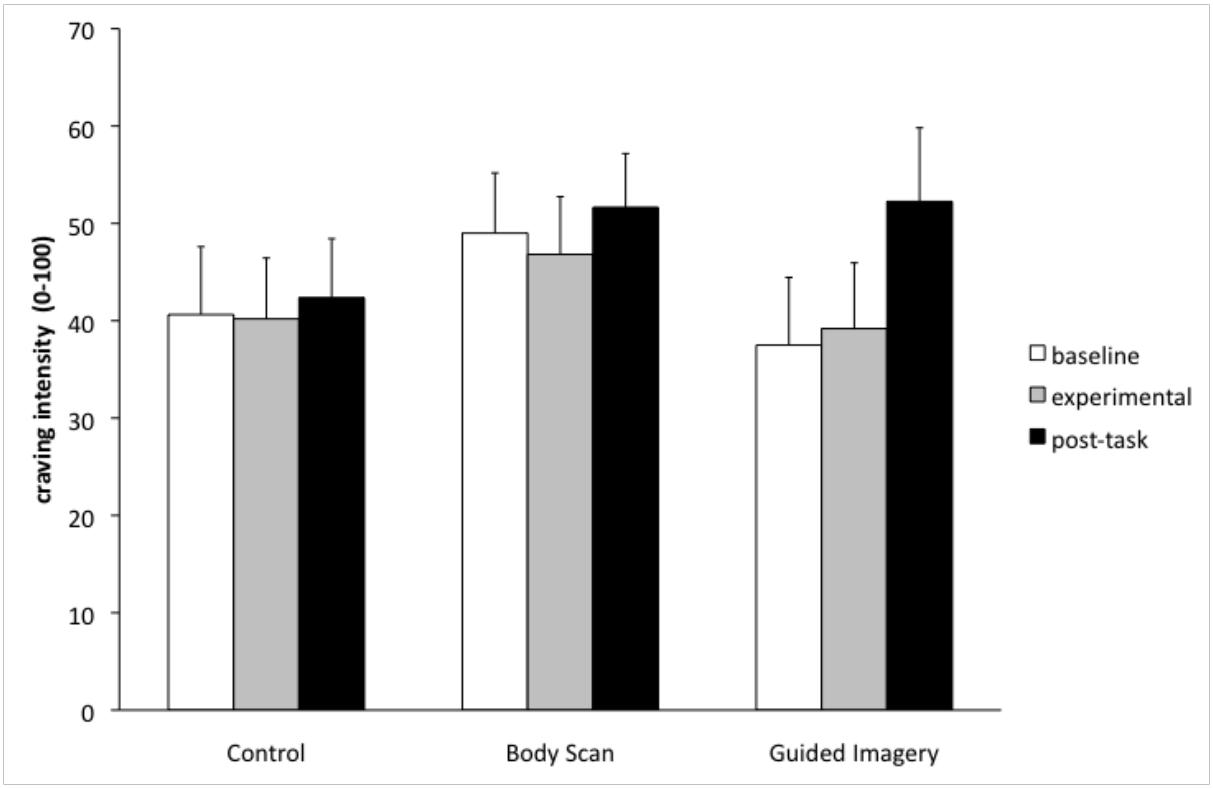

40
35
30
25
20
15
10
5
0
food related thoughts (%)
Control
Body Scan
Guided Imagery
baseline
experimental
post-task

Figure 4


70
60
50
40
30
20
10
0
craving intensity (0-100)
Control
Body Scan
Guided Imagery
baseline
experimental
post-task