Olfactory Stimulation Curbs Food Cravings

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Running head: Odours reduce food cravings

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Abstract

Based on the logic of mutual competition between cravings and odours for limited-capacity resources, this study investigated whether a simple olfactory task, involving a brief odour exposure, could reduce food cravings. In support, Experiment 1 showed that smelling a neutral unfamiliar odorant reduced cravings for highly desired food items, relative to a comparison auditory task and a no-task control condition. Experiment 2 replicated these findings specifically for chocolate cravings, which can be particularly problematic. Thus olfactory stimulation offers potential scope for curbing unwanted food cravings.

Keywords: craving; food; odour; craving reduction

Craving refers to a motivational state characterised by a compulsion to seek and consume a particular substance (Baker, Morse & Sherman, 1986). Although the term usually refers to tobacco, alcohol and other drugs, it has become increasingly applied to food. Food cravings have been described as an intense desire or urge to eat a specific food (Weingarten & Elston, 1990). It is this food specificity that distinguishes a craving from hunger (Pelchat, 2002). Food cravings originate from both physiological and psychological sources, such as nutritional deficiencies (Wardle, 1987), menstrual-related changes (Dye, Warner & Bancroft, 1995), and negative mood states (Hill, Weaver & Blundell, 1991), as well as exposure to the sight or smell of food (Fedoroff, Polivy & Herman, 2003).

Although cravings for food are generally not pathological (Lafay et al., 2001), like those for alcohol, tobacco and drugs, they can be problematic for some people, and pose significant health risks. Specifically, food cravings can trigger binge-eating episodes (McManus & Waller, 1995), which can, in turn, give rise to obesity (Schlundt, Virts, Sbrocco & Pope-Cordle, 1993) and bulimia nervosa (Mitchell, Hatsukami, Eckert & Pyle, 1985). Food cravings have also been associated with impaired cognition (Green, Rogers & Elliman, 2000; Kemps, Tiggemann & Grigg, 2008), and have the potential to disrupt and thwart dieting attempts (Sitton, 1991), leading to feelings of guilt and shame (Macdiarmid & Hetherington, 1995). Because of the seriousness of obesity and eating disorders in contemporary Western society (Polivy, Herman & Boivin, 2005; Wadden, Brownell & Foster, 2002), the development of techniques for curbing unwanted food cravings is of utmost practical importance.

Initial attempts have shown that contemporary craving reduction strategies, such as thought suppression (Johnston, Bulik & Anstiss, 1999) and cue exposure

response prevention (Hetherington, 2001), are not very successful. Subsequent investigations into the cognitive underpinnings of food cravings hold much greater promise. In particular, these have shown that performing a visual or olfactory imagery task can reduce food cravings. For example, Kemps and colleagues (Harvey, Kemps & Tiggemann, 2005; Kemps & Tiggemann, 2007) showed that scripts that asked participants to imagine common sights (e.g., a rainbow) or smells (e.g., eucalyptus) reduced cravings for food and chocolate in a way that imagining everyday sounds (e.g., a siren) did not. Similar effects have been reported on cigarette (May, Andrade, Panabokke & Kavanagh, 2010; Versland & Rosenberg, 2007) and caffeine (Kemps & Tiggemann, 2009) craving reduction.

The finding that competing visual and olfactory images reduce food cravings is consistent with reports that mental imagery is a key feature of cravings, and that craving-related images are predominantly visual and olfactory in nature. Indeed, surveys of everyday food cravings show that respondents use primarily visual (e.g., “I could picture the chocolate cake in my mind”) and olfactory (e.g., “I could smell the aroma of the pizza”) imagery descriptors to characterise their cravings (May, Andrade, Panabokke & Kavanagh, 2004; Tiggemann & Kemps, 2005). According to a recent cognitive model of craving, the Elaborated Intrusion Theory of Desire (Kavanagh, Andrade & May, 2005), the modality-specific craving reducing effect of visual and olfactory imagery tasks stems from a mutual competition for limited cognitive resources. In particular, visual and olfactory imagery tasks reduce food cravings by introducing information in the same sensory modality as the imagery associated with the craving, and thus compete for the same pool of limited-capacity processing resources.

Although visual and olfactory imagery tasks offer potential scope for reducing food cravings, forming mental images is cognitively effortful, and hence, unlikely to be an effective craving reduction technique in a practical sense. Instead, for greater acceptability, we need simpler, relatively undemanding tasks. In the visual domain, simple tasks, such as watching a flickering pattern of random black and white dots, termed dynamic visual noise, have been shown to reduce food cravings (Kemps, Tiggemann & Christianson, 2008; Kemps, Tiggemann & Hart, 2005; Kemps, Tiggemann, Woods & Soekov, 2004; McClelland, Kemps & Tiggemann, 2006; Steel, Kemps & Tiggemann, 2006), as well as cigarette cravings (May et al., 2010). The Elaborated Intrusion Theory of Desire (Kavanagh et al., 2005) would predict that a simple olfactory task should also reduce cravings. In support, Sayette and Parrott (1999) showed that a simple olfactory task involving a brief odour exposure reduced cigarette cravings in smokers.

Thus the aim of the present study was to investigate the effect of smelling an odour on food craving reduction. Analogous to dynamic visual noise in the visual modality, we chose a neutral and unfamiliar aromatic substance (Sulmont, Issanchou & Koster, 2002). To determine its effectiveness, and to control for potential effects of more general distraction, we compared it against a simple auditory interference task, previously shown to only minimally affect food cravings (Kemps et al., 2005). Experiment 1 examined the effects of olfactory craving reduction on food craving in general, while Experiment 2 did so for chocolate craving in particular.

Experiment 1

Method

Participants

Participants were 56 female undergraduate students at Flinders University who took part for course requirements and credit. They were aged between 18 and 34 years (M = 22.16, SD = 3.55). Participants were recruited through an advertisement on the Psychology notice board. Only women were included, because food cravings are more prevalent in women than in men (Weingarten & Elston, 1991). As food cravings are less frequent and less intense in a state of satiety (Cornell, Rodin & Weingarten, 1989; Hill et al., 1991), participants were instructed to abstain from eating and drinking (water was allowed) for two hours prior to testing. All participants reported having complied with this instruction.

Design

The experiment used a within-subjects design, with interference task conditions (control, olfactory, auditory) presented in counterbalanced order.

Materials

The stimuli were 30 digital coloured photographs depicting attractive images of 10 highly desired food categories, 5 sweet (chocolate, cake, ice-cream, muffin, biscuit) and 5 savoury (pizza, hot chips, hamburger, crisps, pasta), with three different pictures per food category. The photographs were presented as a series of Powerpoint slides and divided into three equivalent sets each comprising one picture from each of the 10 categories. Stimulus sets were counterbalanced across interference task conditions. Stimuli within each set were presented in a single random order. The

photographs were selected on the basis of a pilot study in which 12 participants aged 25 to 33 years (M = 28.27, SD = 2.83) rated them as the most representative or prototypical of the 10 food categories from among a total of 186 photographs.

Procedure

Participants were tested individually in a quiet room in the Applied Cognitive Psychology Laboratory in a session of 30 min. duration. They were seated approximately 50 cm in front of an IBM compatible computer with a 17-inch monitor. Participants completed a total of 30 trials, comprising 5 sweet and 5 savoury food pictures for each of the three interference task conditions. On each trial, a stimulus picture was presented for 5 s. Participants were instructed to retain an image of the picture for a further 8 s, while engaging in the assigned interference task activity. They then rated their food craving intensity on a 100-mm visual analogue scale, ranging from “no desire or urge to eat” to “extremely strong desire or urge to eat”. This methodology has been shown to effectively elicit food cravings in the laboratory (Kemps et al., 2004, 2005).

During the retention interval, participants either simply looked at the blank computer monitor (control condition) or also performed the designated interference task (olfactory and auditory conditions). In the olfactory interference task, participants smelled a neutral unfamiliar odour, menthyl acetate. We selected this particular substance from Sulmont et al.’s (2002) list of unfamiliar odorants, because it was recommended and able to be provided by the University’s School of Chemical and Physical Sciences. Following Sulmont et al., the odorant was diluted in mineral oil to a concentration of 40 ml/l; this weak intensity was to guard against olfactory adaptation during testing. The experimenter opened an opaque vial containing the

odour and held it under the participant's nose for the duration of the retention interval, i.e., 8 s. At the end of the retention interval, the experimenter removed and closed the vial. The auditory interference task consisted of irrelevant speech, i.e., foreign language spoken material (Salamé & Baddeley, 1982). Participants heard a recording of a female voice reading a passage from a Dutch newspaper. None of the participants understood Dutch.

Results

Craving ratings were averaged over the 10 trials in each interference task condition. These were analysed by a repeated measures ANOVA, with post-hoc comparisons using a Bonferroni correction for multiple comparisons. Calculations of effect size were based on Cohen's *f*, with cut-off values of .10, .25, and .40 for small, medium and large effects, respectively (Cohen, 1988). Descriptive statistics are shown in Table 1.

There was a significant effect of interference task condition, $F(2, 110) = 14.41$, $p < .001$, $f = .51$. As predicted, post-hoc comparisons showed that craving ratings were significantly lower in the olfactory interference condition than in the auditory interference, $p < .01$, and control, $p < .001$, conditions. Ratings in the auditory interference and control conditions did not differ from each other, $p > .05$.

Additional analyses for the sweet and savoury food categories separately showed the same pattern of results, i.e., a significant effect of interference task condition, $F(2, 110) = 8.73$, $p < .001$, $f = .40$ (sweet), and, $F(2, 110) = 17.40$, $p < .001$, $f = .56$ (savoury), with post-hoc comparisons showing significantly lower craving ratings in the olfactory interference condition than in either of the auditory interference (ps < .01) and control (ps < .001) conditions. In each case, ratings in the

auditory interference and control conditions were not different from one another (*p*s > .05).

Discussion

Performing a simple olfactory task, consisting of sniffing a neutral unfamiliar odour, successfully reduced food cravings. This finding reflects the olfactory imagery based nature of food cravings (May et al., 2004; Tiggemann & Kemps, 2005), and the mutual competition between cravings and odours for the same pool of limited cognitive resources (Kavanagh et al., 2005). It also supports Sayette and Parrott's (1999) finding of cigarette craving reduction following a brief odour exposure, and thus extends this craving reduction protocol to food cravings. Importantly, the observed craving reduction effect cannot be attributed to general distraction, as a comparable auditory interference task did not affect food cravings.

More generally, this experiment shows that a simple olfactory task, like a simple visual task, such as dynamic visual noise, can reduce food cravings. These simple tasks present a less cognitively demanding alternative to imagery-based craving reduction techniques. Simply sniffing an odour also appears to have wide applicability across foods, as it reduced cravings for a range of sweet as well as savoury foods.

Experiment 2

Experiment 1 showed that sniffing a neutral unfamiliar odour reduced cravings for food in general. Experiment 2 aimed to replicate this craving reduction effect on cravings for chocolate specifically. Chocolate is by far the most commonly craved food in Western cultures (Hetherington & Macdiarmid, 1993). Additionally, cravings

for chocolate can be particularly problematic. Specifically, chocolate is considered an indulgence that should be eaten with restraint (Rogers, 1994). In fact, it is often perceived as the "forbidden fruit" in weight-loss diets (Knight & Boland, 1989). However, attempting to resist chocolate intake only increases the desire for it (Rogers & Smit, 2000), which is likely to result in unwanted consumption (Hetherington & Macdiarmid, 1993), particularly as there is no substitute for chocolate when it is craved (Weingarten & Elston, 1991). Unwanted chocolate consumption in response to cravings has been shown to produce feelings of guilt (Macdiarmid & Hetherington, 1995). Chocolate cravings have also been linked to binge eating in women with bulimia nervosa (Mitchell et al., 1985) and overeating in obese women (Bjoervell, Roennberg & Roessner, 1985).

Method

Participants

Participants were 57 female undergraduate students at Flinders University, aged 18 to 30 years (M = 21.04, SD = 3.22). None had taken part in Experiment 1. As in Experiment 1, participants abstained from eating and drinking (water was allowed) for two hours prior to testing. All participants reported that they liked chocolate, in response to the yes/no question "Do you like chocolate?".

Design, materials and procedure

Design, materials and procedure were similar to those used in Experiment 1, except that the stimuli were photographs portraying images of chocolate-containing food categories: chocolate cake (whole), chocolate cake (slice), chocolate bar, brownie, chocolate pudding, chocolate muffin, chocolate ice-cream, chocolate biscuit,

chocolate mousse and chocolate doughnut. These were derived from the previously mentioned pilot study. Again there were three different pictures per food category. The anchors of the craving intensity rating scale were correspondingly modified to “no desire or urge to eat chocolate” and “extremely strong desire or urge to eat chocolate”.

Results

Chocolate craving ratings, averaged across the 10 trials per interference task condition, were analysed by a repeated measures ANOVA. There was a significant effect of interference task condition, $F(2, 112) = 19.57$, $p < .001$, $f = .59$. As can be seen in Table 2, chocolate craving ratings were significantly lower in the olfactory interference condition than in the auditory interference, $p < .01$, and control, $p < .001$, conditions. Ratings were also significantly lower in the auditory interference than the control condition, $p < .05$.

Discussion

The results of Experiment 2 essentially replicated those obtained in Experiment 1. Sniffing a neutral unfamiliar odour clearly reduced chocolate cravings, relative to a comparable auditory interference task and a no-task control condition. This indicates that a brief odour exposure is effective in reducing specific cravings for chocolate, the most commonly craved food substance.

General Discussion

To our knowledge, this series of experiments is the first to examine and show an effect of a simple olfactory task, namely sniffing an odour, on food craving

reduction. Experiment 1 showed craving reducing effects of a neutral unfamiliar odour on cravings for food in general, while Experiment 2 did so for chocolate in particular. These findings support and extend several previous lines of craving research. First, they extend the previously shown craving reducing effects of olfactory imagery (i.e., imagining an odour) to actually smelling an odour (Kemps & Tiggemann, 2007; Versland & Rosenberg, 2007). Second, they extend the use of simple food craving reduction tasks from the visual to the olfactory domain (Kemps et al., 2004, 2005, 2008; McClelland et al., 2006; Steel et al., 2006). And third, they extend the use of a simple olfactory craving reduction technique from cigarette to food cravings (Sayette & Parrott, 1999).

Theoretically, the current findings fit well with the olfactory imagery based nature of food cravings (May et al., 2004; Tiggemann & Kemps, 2005) and with the mutual competition for limited capacity resources between odours and cravings. In particular, according to the Elaborated Intrusion Theory of Desire (Kavanagh et al., 2005), odours reduce cravings by introducing information in the same sensory modality as the imagery associated with the craving, and thus compete for the same pool of limited-capacity resources.

At a more practical level, simply sniffing an odour provides a much less cognitively demanding alternative to imagining odours, and hence, is more likely to be adopted as a craving reducing technique. Thus olfactory stimulation could provide a particularly useable tool for curbing unwanted food cravings, implicated in both weight gain and binge eating disorder (McManus & Waller, 1995; Schlundt et al., 1993). It remains to be seen as to which specific odours might provide the best craving reduction stimulation. Here we used a neutral unfamiliar odour, and a recent paper has suggested that a non-food odour would be more effective than a food odour

(Kemps, Tiggemann & Bettany, 2012). Future research also needs to determine how long the craving reducing effect will last, given that people may habituate to odours quite quickly.

In each experiment, cravings were induced visually by showing participants pictures of food or chocolate. This has a high degree of ecological validity as people are often exposed to such visual food cues through advertising on television and in magazines. Our previous research has shown positive effects of a visual craving reduction technique following visual induction of the craving (Kemps et al., 2004, 2005). The finding here that an olfactory task reduced food cravings that were induced visually provides clear evidence that it is the sensory modality of the craving itself, rather than that of the craving induction procedure, that is important. Future research could further test this proposition by including an olfactory craving induction protocol whereby cravings are elicited via exposure to the smell of food.

Like all studies, the present research carries a number of limitations. First, participants were all university students of mostly normal weight. To the extent that simple olfactory tasks have clinical utility, future research needs to test the applicability of this craving reduction technique in samples of individuals for whom food cravings are problematic, such as binge eaters and overweight or obese individuals who are trying to lose weight (Gendall, Joyce, Sullivan & Bulik, 1998; McManus & Waller, 1995; Sitton, 1991). Second, the current experiments measured craving by self-report, a common practice that has been argued to provide the best and most appropriate assessment of what is essentially a subjective experience (Pelchat, 2002). Similar measures have been used in cigarette craving research, and have been shown to be more sensitive to experimental smoking urge manipulations than physiological responses (Carter & Tiffany, 1999). Nevertheless, if craving drives

consumption, as is widely accepted (e.g., Robinson & Berridge, 1993), the craving reducing impact of simple olfactory tasks needs to be extended to behavioural measures. Third, there was no baseline measure of craving, and so it may be that sniffing the odour prevented the craving from developing rather than reducing it. However, this is unlikely, as other studies have shown the procedure we used to elicit craving (Kemps et al., 2004, 2005). In addition, Sayette and Parrott (1999), whose design did include a baseline measure of cigarette craving, also reported lower craving ratings following odour exposure compared to a control condition. Finally, food cravings were induced experimentally in a laboratory setting. Future research needs to replicate the present laboratory findings for naturally occurring food cravings.

In sum, the present set of experiments adds to the growing body of literature on food craving. Theoretically, our findings support the argument that odorants can effectively suppress food cravings through mutual competition for limited-capacity resources and thereby support the Elaborated Intrusion Theory of Desire. Practically, we provide a relatively simple olfactory technique that warrants development as a useful way to curb unwanted food cravings.

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Table 1

Means and standard deviations for food craving ratings for the three interference task conditions in Experiment 1

	Total		Sweet		Savoury	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	57.11	20.31	56.52	21.10	57.70	21.49
Olfactory interference	44.44	21.08	45.42	22.42	43.46	21.41
Auditory interference	52.32	22.96	51.84	23.21	52.79	23.81

Table 2

Means and standard deviations for chocolate craving ratings for the three interference task conditions in Experiment 2

	M	*SD*
Control	57.96	22.68
Olfactory interference	43.65	21.86
Auditory interference	51.92	24.45