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Olfactory stimulation curbs 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.

1. Introduction

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, Harvey, Kemps, and Tiggemann (2005) and Kemps and 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

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and white dots, termed dynamic visual noise, have been shown to reduce food cravings (Kemps, Tiggeman, & Hart, 2005; Kemps, Tiggemann, & Christianson, 2008; 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.

2. Experiment 1

2.1. Method

2.1.1. 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 2 h prior to testing. All participants reported having complied with this instruction.

2.1.2. Design

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

2.1.3. 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.

2.1.4. 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.

2.1.5. 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 ($ps > .05$).

2.1.6. 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

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