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"Smile away your cravings" – Facial feedback modulates cue-induced food cravings

Jennifer Schmidt*, Alexandra Martin

University of Wuppertal, Department of Clinical Psychology and Psychotherapy, Germany

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ABSTRACT

Food cravings are common experiences that precede dysfunctional eating behaviors, such as overeating and binge eating. These cravings are often related to negative affect, especially in emotional eaters. Recent studies have revived interest in a theory on the implicit modulation of affect: the facial feedback-hypothesis. This theory claims that mimic expressions influence affective experiences. Given the association between negative affect and food craving, facial feedback could provide a means to reduce or prevent food cravings.

In an experimental study, using a read aloud task, we examined, whether an implicit modulation of facial muscle activity – zygomatic muscle (smiling: FF+) and corrugator muscle (frowning: FF-) – would alter food cue-induced cravings in healthy young women ($n = 60$). We further examined, if traits in emotional eating influence the facial feedback-effect.

The activation of the zygomatic muscle prevented the occurrence of food cravings after exposure with palatable food cues. Food craving only increased in the FF- group ($p = 0.029$). The facial feedback effect was especially pronounced in emotional eaters, indicated by a significant moderation ($p = 0.041$). In participants with high degrees of emotional eating, food craving was reduced in the FF + group and amplified in the FF- group.

The results indicate that mimic expressions might influence food cravings on implicit pathways. Existing approaches that target implicit behavior modification via facial feedback may be transferable to eating behavior. These methods could potentially help in altering dysfunctional eating associated with food craving, especially in individuals prone to emotional eating.

1. Introduction

The intense and urging desires to consume specific foods, like chocolate or pizza, are commonly known as *food cravings*. These motivational states are highly prevalent among many individuals, especially in women (Lafay et al., 2001; Pelchat, 2002; Weingarten & Elston, 1991) and in Western *obesogenic* environments (Morris, Beilharz, Maniam, Reichelt, & Westbrook, 2015; Swinburn et al., 2011). Food cravings become detrimental when they occur frequently, because they can initiate unhealthy eating behaviors, like overeating and binge eating (Chao, Grilo, & Sinha, 2016). They may also undermine and boycott dieting intentions and therefore establish a pitfall for failure in weight control attempts (Meule, Lutz, Vögele, & Kübler, 2012). As long term results, distress, weight gain and disordered eating - for example, binge eating disorder - may develop (Boswell & Kober, 2016; Ng & Davis, 2013; van den Eynde et al., 2012).

Given these potential negative outcomes, researchers have recently examined techniques to prevent or reduce food cravings on the level of automatic and implicit processes. For example, Jansen, Schyns, Bongers, and van den Akker (2016) highlighted the potential of repeated cue exposure with response prevention to extinguish conditioned appetitive responses to food cues. The research group introduced several promising findings on the efficacy of cue exposure treatments in reducing food cravings and binge eating (e.g., Coelho, Nederkoorn, & Jansen, 2014; Schyns, Roefs, Mulkens, & Jansen, 2016).

Another technique to tackle food cravings has been provided with regard to implicit bias modification. In a pilot trial,

* Corresponding author. University of Wuppertal, School of Human and Social Sciences, Clinical Psychology and Psychotherapy, Max-Horkheimer-Str. 20, D-42097 Wuppertal, Germany.
E-mail addresses: jschmidt@uni-wuppertal.de (J. Schmidt), martin@uni-wuppertal.de (A. Martin).

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Brockmeyer, Hahn, Reetz, Schmidt, and Friederich (2015) showed that an approach avoidance-training, based on the postural rejection of high caloric food cues (pushing away images with a joystick), reduced the implicit approach bias and subsequent state food craving in participants with habitual food cravings and subclinical bulimic pathology.

While external cues and inherent biases towards these stimuli mark important facilitators for the occurrence of food cravings (e.g., Hou et al., 2011; Schag, Schönleber, Teufel, Zipfel, & Giel, 2013; Yokum, Ng, & Stice, 2011), another potential mechanism is neglected in these approaches. Internal cues, especially affective states of tense negative arousal, have been identified as factors involved in the occurrence of food cravings (e.g., Bohon & Stice, 2012; Dubé, LeBel, & Lu, 2005; Wagner, Boswell, Kelley, & Heatherton, 2012). Several theories and strong empirical evidence suggest that food cravings and binge eating are closely linked to negative affect (Haedt-Matt & Keel, 2011; Macht, 2008; Selby, Anestis, & Joiner, 2008; Waters, Hill, & Waller, 2001). Food cravings may thus manifest as correlates of the urge to regulate aversive affective states (Bongers, van den Akker, Havermans, & Jansen. 2015; Leehr et al., 2015).

Yet, for a modulation of negative affective states, another implicit process can be relevant: the effect of *facial feedback* (e.g., Buck, 1980; Zajonc, 1985). The facial feedback-hypothesis states that facial mimics influence an individual's emotional experience. Experiences of happiness would thus be either initiated, augmented, or modified due to muscular activation of the zygomatic muscle, the 'smiling muscle'. Negative emotional experiences would in turn be influenced by a contraction of the corrugator muscle, the 'frowning muscle' (for reviews, see McIntosh, 1996; Niedenthal, Augustinova, & Rychlowska, 2010; Price, Peterson, & Harmon-Jones, 2012).

The theory has received empirical support in various experimental studies regarding the modulation of affective responses (Davis, Senghas, & Ochsner, 2009; Dimberg, Thunberg, & Elmehed, 2000; Hennenlotter et al., 2009; Hess, Kappas, McHugo, Lanzetta, & Kleck, 1992; Soussignan, 2002). For example, Strack, Martin, and Stepper (1988) found that participants who contract the zygomatic muscle rated comics as funnier than those who inhibited this muscle. Zajonc, Murphy, and Inglehart (1989) instructed German participants to recite stories containing many words including the vowel *ü* (pronunciation inhibits the zygomatic and increases corrugator muscle activity). Stories with frequent *ü*-words received more negative ratings than stories without this letter.

Recently, attention for the facial feedback hypothesis has been revived with new evidence regarding its application in the field of mental disorders. In several well-controlled studies, researchers found that paralysis of the corrugator muscle, induced via injections with botulinum toxin A (Botox®), is effective in reducing depressive symptoms (for a review, see Finzi & Rosenthal, 2016). Positive facial feedback has also been reported to attenuate stress experiences (Kraft & Pressman, 2012). Such results imply that facial muscle activity can indeed implicitly alter states related to distress. As stated by Finzi and Rosenthal, it would be a logical step to extend the examination of facial feedback effects to other conditions associated with negative affect (2016, p. 95). Despite of the known relation of negative affect and eating behavior or motivations, the facial feedback effect has to date not been examined in this regard.

We were therefore interested in analyzing, if facial feedback during food cue exposure would exert effects on induced food cravings. In an experimental study, we aimed at implicit modulations of facial muscle activity via a read aloud paradigm while presenting appealing food cues. In one of the groups, all recited words contained the German letters *ü* and *ö* as dominant vowels (corrugator activation/zygomatic inhibition: FF- group). In the other group, the dominant vowels were *e* and *i*, (zygomatic activation: FF + group). We hypothesized that manipulated facial expressions would influence self-reported, cue-induced food cravings, with higher cravings in the FF- group than in the FF + group.

Researchers have further highlighted, how trait-like eating behaviors may influence the effects of techniques to alter food cravings (Rodríguez-Martín & Meule, 2015; van Strien, Herman, Anschutz, Engels, & de Weerth, 2012). We therefore aimed at investigating the influence of trait emotional eating, that is, increased food consumption in the face of aversive emotional states (van Strien, Frijters, Bergers, & Defares, 1986). Here, we hypothesized an even stronger effect: Because affective states exert a stronger influence on the behavior of emotional eaters, we expected food cravings to be augmented in the FF- group and reduced in the FF + group.

2. Method

Study design

The experimental study was conducted in a 2 × 2 mixed-design in young women. Time of assessment was the within-subjects factor (pre vs. post experimental manipulation) and group was the between-subjects factor: manipulation of zygomatic muscle activity via e/i-words (FF+) versus manipulation of corrugator muscle activity via ü/ö-words (FF-). Group allocation was carried out via a computer generated randomization algorithm.

We used a cover story on concentration and attention during distraction by food cues, to assure that participants would not be aware of the experimental hypothesis. Herewith, we aimed at avoiding demand characteristics within the sample, which have been criticized as influential in general experimental (Nichols & Maner, 2008) and particularly in facial feedback studies (Buck, 1980; Strack et al., 1988).

The experiment took place from May to July 2016 in a laboratory at the University of Wuppertal, Germany. All procedures were conducted in compliance with ethical standards of the Helsinki declaration and in line with requirements of the local university's ethics committee. Each participant provided written informed consent and was debriefed on the purpose of the study when the data collection was finished.

Sample

A total of 61 German female participants, aged 19–37 years, participated in the study. They either volunteered without any allowance or received course credit if they were enrolled as psychology-students. The majority of the subjects were students (81.7%) and had a Body Mass Index (BMI) in the normal range ($M = 22.9$ kg/m^2, $SD = 4.9$ kg/m^2).

Measures

Demographics and screening

We assessed demographics prior to the experiment via a computer-questionnaire. Here, participants reported their age und current employment. They further provided their height and were weighed on a personal scale after the experiment, for BMI calculation (weight in kg divided by squared height in m).

State measures: food craving, hunger, mood, and distractor variables

For the assessment of state food craving and state hunger, we used visual analogue scales (VAS, range: 0 = *not existent*; 100 = *extremely*) for ratings before and after the experimental task.