

Impact of BMI and gender on cross-modal interactions in custard desserts

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Introduction

Food perception and food liking are the result of multiple sensory modalities, including visual, gustatory, olfactory, and somatosensory inputs (Small & Prescott, 2005). Our ability to detect the sensory properties is mainly due to our sense of smell more than other senses (Murphy et al. 1977). It has been suggested that eating behavior of obese subjects is more directed by external cues, such as odors, than by internal cues (Herman and Polivy, 2008). Surprisingly the differences in olfactory functions between normal weight and obese subjects and the interaction of the sense of smell with other modalities is poorly studied in relation to nutritional status (Richardson et al 2004; Stafford & Welbeke 2011). Only recently it has been suggested that the cross modal interactions occurs differently in relation to Body Mass Index (BMI) in women subjects (Proserpio et al. 2016).

The aim of the present study was to go further in the investigation of food cross-modalities interaction by examining whether adding a butter aroma to a model custard dessert affect differently the perception of sensory properties (sweetness, vanilla and butter flavors, and creaminess) and the acceptability in normal weight (NW) and obese (OB) male and female subjects.

Material and methods

45 NW (BMI=22.03 ± 2.14 Kg m⁻²; females n=21; males n=24) and 46 OB (BMI=37.52 ± 5.07 Kg m⁻²; females n=26; males n=20) attended two sessions. In the first session, liking assessment of three custard samples, with increasing concentration of butter aroma was evaluated in the pre-prandial condition. Subjects evaluate their liking for each sample using a labeled hedonic scale (LAM), anchored by the extremes of “greatest imaginable dislike” (rated 0) and “greatest imaginable like” (rated 10) (Schutz & Cardello, 2001). In the second session, the same subjects evaluated the sensory properties (sweet taste, vanilla and butter flavors, and creaminess) of the custard samples. All subjects were first instructed on how to use the generalized Labeled Magnitude Scale (gLMS) (Green et al., 2012).

Results and discussion

Mixed model analysis showed that the interaction *BMI x samples* had a significant effect on the perceived intensity of sweetness (p<0.0001), vanilla flavor (p<0.0001), creaminess (p<0.001) and on acceptance (p<0.0001). According to post-hoc analysis, the addition of butter aroma, signaling energy dense products, elicited stronger odor-taste, odor-flavor and odor-texture interactions in OB than in the control group. Butter aroma addition, without adding calories, increased OB perception of sweet taste, vanilla flavor and creaminess, which are all desirable sensory attributes in a custard dessert. Therefore, adding an odor that is normally associated with a high-fat food led to different cross-modal integrations in a more effective way in subjects with higher BMI compare to NW. Sample with the higher concentration of butter aroma obtained significant higher liking score (p<0.0001) compare to the other samples only in the OB group. This support the hypothesis that

a greater liking could result in more consumption of this type of product by OB. Everyone is inclined to eat more of pleasant food than one that is not. However, those who are overweight reply to satisfying foods by eating even more than do normal weight individuals (Salbe et al. 2004). Accordingly, it has been shown that overweight subjects prefer fatty and sweet foods (Bartoshuk et al. 2006).

The interaction *BMI x gender* had a significant effect on liking ($p < 0.05$), on perceived sweetness ($p < 0.01$) and on vanilla flavor ($p < 0.05$). Post-hoc analysis revealed that OB women gave significantly higher liking, sweetness and vanilla flavor scores compared to NW women ($p < 0.0001$). OB men gave significantly higher scores than NW men only for acceptance ($p < 0.0001$). Moreover, OB females perceived more the sweetness and the vanilla flavor than OB males (respectively $p < 0.01$; $p < 0.0001$).

Conclusion

Obese subjects seemed to pay more attention than normal weight subjects to stimuli signaling high-calorie products. The addition of the butter aroma, without adding calories, increased the liking and the sensory perception of all the sensory characteristic more in the obese subjects than in the control group. Understanding cross-modal interactions in relation to nutritional status and gender is interesting in order to develop new food products with reduced sugar and fat, which are still satisfying for the consumer. This could have implications in reducing caloric intake and tackle the obesity epidemic.

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