Perception, 2010, volume 39, pages 1684 – 1686

doi:10.1068/p6784

SHORT AND SWEET

An illusion you can sink your teeth into: Haptic cues modulate the perceived freshness and crispness of pretzels

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Received 29 July 2010, in revised form 22 October 2010

Abstract. Eating is a multisensory experience involving more than simply the oral sensation of the taste and smell of foods. It has been shown that the way foods look, sound, and feel like in the mouth all affect food perception. The influence of haptic information available when handling food is relatively unknown. In this study, blindfolded participants bit-into fresh or stale pretzels while rating their freshness – staleness and crispness – softness. Information provided to the hand was either congruent (whole pretzel fresh or stale) or incongruent (half pretzel fresh, half stale) with what was presented to the mouth. The results demonstrate that the perception of both freshness and crispness was systematically altered when incongruent information was provided: bit-into fresh pretzel tips were perceived as staler and softer when a stale pretzel tip was held in the hand and vice versa. Haptic information available when handling food thus plays a significant role in modulating food perception.

When we bite into food, the ways the food looks, sounds, smells, tastes, and feels like in the mouth all contribute to our perception and assessment of the food (see Zampini and Spence 2010 for a review). Although information about the properties of food is available through handling it prior to biting, the influence on food perception of haptic information available when handling food has not been explicitly investigated. Vickers (1975) previously found that the perceived crispness of foods differs depending on whether food is manipulated with the hands (eg by bending, tapping on a plate, etc) or bit-into with the teeth. In the present study I attempt to show that it is possible to modify the perceived textural attributes of pretzels received by the mouth simply by modifying the textural attributes presented to the hand. This research was motivated by recent studies that have shown that the perception of food and drink properties can be changed by manipulating other sensory cues associated with them (Beeli et al 2005; Crisinel and Spence 2010; Masuda et al 2008; Zampini and Spence 2004, 2005). If haptic information from the hand is integrated with information from the mouth, then one would expect that a bit-into hard pretzel tip will be perceived as staler and softer when a soft pretzel tip is held in the hand and vice versa.

Ten naive participants (eight males; nine right-handers; mean age = 34 years, SD = 8.4 years) participated in this study which was performed in accordance with the ethical standards laid down in the revised Declaration of Helsinki of 2008. Participants were blindfolded and seated comfortably at a table. On each trial participants received from the experimenter one end of a pretzel between their index fingers and thumbs of the dominant hand. 12 cm long pretzels from the same package were used (Lorenz Saltletts Sticks, Isenburg, Germany; 8 months prior to best-before date). Of the 40 pretzels used for each participant, 10 were fully immersed in water for 20 s, 20 were immersed in 3 cm of water for 20 s, and the remaining 10 pretzels were kept fresh. Water-treated pretzels were patted dry with paper towel and left to dry in air with stale ends down for 30 min. After this time pretzels and pretzel tips which had been treated were markedly soft but remained intact and dry. In congruent conditions both ends of the

pretzel were either untreated or treated. In incongruent conditions one end of the pretzel was untreated, the other treated, with one end or the other presented initially to the hand.

Participants were instructed to make a single bite using their front teeth (cf Vickers 1975) into the pretzel and then to spit the pretzel out (without chewing or swallowing) onto a plate. Participants verbally reported the freshness and crispness of each randomly presented pretzel with 0 indicating "stale" or "soft" and 100 indicating "fresh" or "crisp", respectively. Participants were instructed that these semantic anchors were opposite to each other and were given unlimited time to complete these ratings.

The data from the fresh – stale and crisp – soft response scales are presented in figures 1a and 1b, respectively. When information presented to the mouth was congruent with that presented to the hand, untreated pretzels were rated 83.9 fresh and 86.6 crisp, while treated pretzels were rated 15.0 fresh and 9.4 crisp on average. The effect of presenting incongruent information to the mouth and hand was highly significant for ratings of both freshness ($t_9 = 8.05$, $p < 0.001$) and crispness ($t_9 = 3.38$, $p = 0.008$). When incongruent information was provided, untreated pretzel tips were rated less fresh (52.6; $t_9 = 5.17$, $p < 0.001$) and less crisp (72.9; $t_9 = 2.36$, $p = 0.042$) than whole untreated pretzels; treated pretzel tips were rated fresher (29.2; $t_9 = 4.20$, $p = 0.002$) and crisper (14.0; $t_9 = 5.60$, $p < 0.001$) than whole treated pretzels. Participants judged pretzels with congruent information with greater precision (lower standard deviation) than when information was incongruent when estimating freshness ($t_{19} = 2.32$,

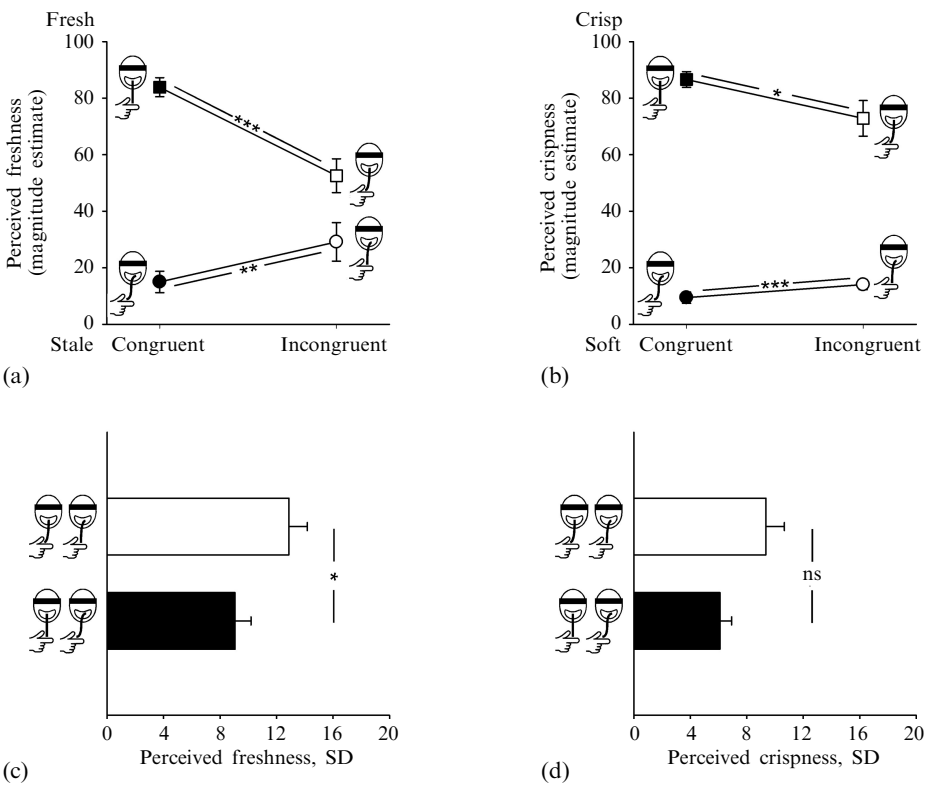

Figure 1. Perceived freshness (a) and crispness (b) when biting into an untreated (squares) or treated (circles) end of a pretzel with congruent (black) or incongruent (white) haptic information. Average standard deviation (SD) for perceived freshness (c) and crispness (d) with incongruent (white) or congruent (black) haptic information. Error bars indicate ±1 SE; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

$p = 0.032$—figure 1c). This effect did not reach significance when estimating crispness ($t_{19} = 1.80$, $p = 0.087$—figure 1d).

The ability to correctly identify the properties of food prior to consumption is critical for survival. To avoid food poisoning, humans and other animals rely on prior assumptions about food properties in order to distinguish fresh from stale food. Because we associate freshness with crispness and firmness (see Vickers and Bourne 1976 for a review) we can rely on these associations and use our hands to seek out the freshest (ie firmest) apples at the market. Thus, without direct contact with foodstuffs (eg packaged foods) we must rely on the best-before date printed on the package. Indeed, the analysis of the data reported here reveals that the perceived freshness and crispness of foods can be modified simply by changing haptic information presented to the hand. Stale pretzel tips were judged to be 94% fresher and 49% crisper when the hand held a hard pretzel tip. Fresh pretzel tips were 38% staler and 16% softer when the hand held a soft pretzel tip. Two possible explanations exist for this effect. As pretzels were always first presented to the hand and only then to the mouth, we might suspect that a change in expectation built up from handling the pretzel could lead to biased estimates. Alternatively, participants' estimates may have been derived from the integration of information presented to the mouth and hand. As participants' estimates were more precise when congruent information was available, the latter explanation is reasonable; however, future studies are required to fully assess whether information provided to the mouth and hand while eating is integrated in a statistically optimal manner (see Ernst and Banks 2002). Within this framework it would also be interesting to determine whether comparable results can be obtained with foods which are handled with utensils, and with foods which are naturally soft.

Acknowledgment. The author was supported by a Max Planck Society stipendium.

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