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# The role of expectancy in sensory and hedonic evaluation: The case of smoked salmon ice-cream

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ABSTRACT

Our experience of flavour involves integration of multiple sensory inputs, and the hedonic evaluation of this complex flavour experience is important in determination of food choice. The appearance of food also generates expectations about food flavour, and past work suggests that these expectations if confirmed enhance the flavour experience. What is less clear is what happens when cues prior to ingestion predict a flavour which is in marked contrast to the actual flavour characteristics. To test this, we conducted three experiments where expectations about food flavour were generated by plausible but inaccurate food labels for a highly novel food, smoked-salmon ice-cream. In Experiment 1, the experience of the food in the mouth generated strong dislike when labelled as ice-cream, but acceptance when labelled as frozen savoury mousse. Labelling the food as ice-cream also resulted in stronger ratings of how salty and savoury the food was than when labelled as a savoury food. Experiment 2 confirmed these findings, and also found that an uninformative label also resulted in acceptable liking ratings. Experiment 3 explicitly tested the effect of labels on flavour expectation, and confirmed that the ice-cream label generated strong expectations of a sweet, fruity flavour, consistent with the visual appearance of the ice-cream, but in marked contrast to the flavour of salty fish. As in Experiments 1 and 2, liking was minimal when the food was tasted after the ice-cream label condition, but liking was acceptable in the other label conditions. These data show that the contrast between expected and actual sensory qualities can result in a strong negative affective response and enhancement of the unexpected sensory qualities.



## 1. Introduction

Although the senses are anatomically separate, they rarely operate independently since the majority of stimuli in the environment stimulate multiple senses. The increased recognition that our sensory experience reflects integration of these multiple sensory inputs has been applied to many experiences, most notably in the current context to our experience of food flavour (e.g., Delwiche, 2004; Keast, Dalton, & Breslin, 2004; Small, Jones-Gotman, Zatorre, Petrides, & Evans, 1997). Although the experience of the sensory qualities of a food are often described in terms of how it "tastes", in practice this experience of flavour is a complex interaction between multiple sensory experiences. Arguably, multi-sensory integration may be at its most extreme in the case of flavour perception since few other experiences offer the opportunity for concomitant stimulation of all the major senses: gustation through the five primary tastes, olfaction through both ortho- and retronasal stimulation of olfactory receptors by volatile compounds released from food, mechanoreception contributing to our perception of texture and providing information on temperature, pain arising from oral irritants and hearing that results from sounds and vibrations coming from the mouth contributing to our perception of aspects of texture. The focus of the present paper is on a further aspect of the multi-sensory experience of flavour, how expectations about food flavour arising from visual and cognitive cues prior to ingestion modify our hedonic and sensory experience of the flavour of food in the mouth.

The visual appearance of a food is well known to influence flavour recognition. Thus many studies have shown that the presence of a congruent colour enhances the ability to identify food and drink stimuli, relative to presentation of the same stimuli without a colour cue or with an incongruent colour (Dubose, Cardello, & Maller, 1980; Stillman, 1993; Teerling, 1992). Further evidence of cross-modal associations within food-related stimuli involving visual cues comes from studies of interactions between visual and olfactory stimuli. For example, when a white wine was coloured red, the sensory descriptors applied to the odour of the wine were consistently terms used normally for red rather than white wine (Morrot, Brochet, & Dubourdieu, 2001). Thus, in the absence of

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appropriate visual cues, the actual olfactory quality of the wine had little impact on the way in which the wine odour was described, with instead the colour predominating. Likewise, explicit detection of both food-related and non-food odours was enhanced when the odour was presented alongside a congruent picture (e.g., ice-cream picture presented with vanillin, see Gottfried, & Dolan, 2003), and likewise speed and accuracy of odour detection was faster for congruent odour-colour pairings (e.g., strawberry odour and pink colour) than for incongruent pairings (Luisa Dematte, Sanabria, & Spence, 2006). One explanation for these effects is that the visual cue sets up an expectation of the flavour to be experienced in the mouth as a consequence of past associations between the visual appearance and perceived flavour of similar food stimuli. Indeed, it has been argued that such associations are likely to be memorised without any explicit attention or learning (Koster, Prescott, & Koster, 2004), highlighting further the key role of memory in developing food-based expectancies (Mojet, & Koster, 2005).

An important methodology in examining the role of expectations in determining our experience of flavour has been to manipulate the congruence between pre-ingestive visual and cognitive cues and the actual sensory quality (taste and/or odour) once the sample has been ingested, extrapolating the exploration of the effects of congruence in interactions between tastes and odours (Frank, & Byram, 1988; Labbe, Damevin, Vaccher, Morgenegg, & Martin, 2006). In most circumstances, visual cues will be a reliable indicator of the actual flavour quality of a food, both in terms of overall recognition of the nature of the food and also whether the food is in an appropriate state to be ingested. However, when there is a lack of congruence between the expected and actual sensory quality of a food, this may lead to perceptual confusion and so alter the sensory experience itself.

Alongside a clear literature on the extent to which visual appearance may alter our ability to identify, and to some extent modify the sensory quality of a food or drink, the extent to which expectations about flavour also modify our hedonic evaluation of a food has also received attention (Cardello, 2007; Deliza, & Macfie, 1996). Actual food choice often occurs based on written or verbal description of a food, even before the actual food has been seen. Thus, in restaurants our choice is based on expectations of liking for flavours implicit in descriptions of the potential foods on offer, with the expectation that the description and actual sensory quality will be congruent. In relation to food flavour, congruence has been defined as "the extent to which two stimuli are appropriate for combination in a food product" (Schifferstein, & Verlegh, 1996), and has been widely used to denote the impact of perceptual similarity between elements in food flavour on changes in sensory quality. For example, perceptual similarity between an odour and taste was a good predictor of taste intensity (Frank, Shaffer, & Smith, 1991).

Expectations about the sensory quality of a stimulus can alter liking and perception of that stimulus in two contrasting ways. Firstly, the sensed and expected sensory qualities may combine, so resulting in actual evaluations which are closer to the expected evaluation than is seen when the same item is evaluated without prior expectation. These outcome can be explained by assimilation theory, first proposed in relation to attitudinal change in social psychology (Hovland, Harvey, & Sherif, 1957), where attitudes are adjusted by prior expectation. In relation to perception of the qualities of food stimuli, many studies have reported assimilation effects, both in relation to affective (liking) evaluations and sensory evaluations (Cardello, & Sawyer, 1992; Deliza, & Macfie, 1996; Kahkonen, Tuorila, & Rita, 1996; Lange, Rousseau, & Issanchou, 1999; Schifferstein, Kole, & Mojet, 1999; Tuorila, Cardello, & Lesher, 1994). For example, verbal descriptions which implied that a product (pomegranate juice) was very pleasant (e.g. the statement that the product scored 8.1 on a 9 point liking scale) or very unpleasant (e.g., that it scored 1.9 on a 9 point liking scale) generated expectations in line with these ratings (Cardello, & Sawyer, 1992). Accordingly, a positive expectation lead to a small increase in actual rated liking on tasting the product (assimilation) although an expectation of a disliked flavour had minimal effects on actual liking for the tasted product. Effects on sensory qualities were clearer: being told that a product had a bitter taste increased rated bitterness on tasting, while expectations of low bitterness tended to decrease bitterness evaluations. The authors concluded that the study provided evidence for the assimilation model: actual and expected sensory experience combined to generate the overall flavour experience and liking. In relation to evaluation of liking, recent research conducted under semi-naturalistic conditions in a cafeteria supports the idea of assimilation. Thus, the use of evocative descriptive menu names resulted in stronger positive evaluations of the food after it had been consumed than when the same food had been labelled by nutritionally accurate but non-evocative names (Wansink, van Ittersum, & Painter, 2005). Likewise, labelling a tomato soup with a name implying a higher quality (e.g., "Gastronome's Connoisseur's Choice Cream of Tomato" relative to "McTaggart's Lean and Low Tomato") resulted in significantly higher hedonic ratings for the same soup regardless of actual nutrient content (Yeomans, Lartamo, Procter, Lee, & Gray, 2001), and also resulted in higher ratings of creaminess of the soup.

In the examples above, actual evaluations of foods generally changed to be more in line with the expected quality even though there was a discrepancy between the expected and actual qualities of these stimuli. However, as discussed earlier, although most studies of effects of expectations on evaluations of foods result in assimilation, in some cases such discrepancies can lead to a decrease in the rated quality (contrast effect) rather than assimilation For example, a strong expectation that an unusual breath freshener (Jintan) had a pleasant taste (ie was a form of "Japanese candy") resulted in markedly lower liking ratings than when Jintan was assessed without expectation (Zellner, Strickhouser, & Tornow, 2001).

A key question is then what determines whether information about a product leads to an enhanced evaluation (assimilation) or a decrease (contrast)? Recent reviews suggest a number of factors may be important (Cardello, 2007; Schifferstein, 2001). Firstly, the size of the discrepancy: where the difference between actual and expected qualities are small, the difference may not be noted, and so assimilation takes place, whereas if the discrepancy is large, contrast may occur. This effect is captured well by the affect expectation model (Wilson, Lisle, Kraft, & Wetzel, 1989). Where the discrepancy is not apparent, the expectation is no longer a point of reference and so is not directly compared with the actual qualities. In relation to food, several studies report findings consistent with this idea (see Cardello, 2007 for review). A second factor is the strength of the expectation: even where there is a large discrepancy between expected and actual properties, assimilation may occur if the expectation is very strong. In relation to food, an important test of these ideas was reported by Zellner et al. (2001). Their participants' evaluated two novel foods, Jintan and guanabana nectar, with expectation about liking manipulated by the information provided beforehand. Assimilation occurred where expectation were based on specific information about the nature of the food (e.g., where participants assessing Jintan were told that other assessors had rated this as very disliked), even when the extent of the expected dislike was much greater than that seen when the food was evaluated without prior expectations, but contrast was seen where the expectation and actual experience were very different. The findings by Zellner and colleagues are important since they contrast with a larger literature suggesting assimilation is the normal response to disconfirmed expectancies with food, discussed earlier. One reason for this may be that most previous