



Research review

Colour, pleasantness, and consumption behaviour within a meal



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ABSTRACT

It is often claimed that colour (e.g., in a meal) affects consumption behaviour. However, just how strong is the evidence in support of this claim, and what are the underlying mechanisms? It has been shown that not only the colour itself, but also the variety and the arrangement of the differently-coloured components in a meal influence consumers' ratings of the pleasantness of a meal (across time) and, to a certain extent, might even affect their consumption behaviour as well. Typically, eating the same food constantly or repeatedly leads to a decrease in its perceived pleasantness, which, as a consequence, might lead to decreased intake of that food. However, variation within a meal (in one or several sensory attributes, or holistically) has been shown to slow down this process. In this review, we first briefly summarize the literature on how general variety in a meal influences these variables and the major theories that have been put forward by researchers to explain them. We then go on to evaluate the evidence of these effects based mainly on the colour of the food explaining the different processes that might affect colour-based sensory-specific satiety and, in more detail, consumption behaviour. In addition, we also discuss the overlap in the definitions of these terms and provide additional hypothesis as to why, in some cases, the opposite pattern of results has been observed.

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Introduction

There is now a very large body of empirical evidence to support the claim that increased *variety* in terms of the gustatory, olfactory, and/or oral-somatosensory attributes of a meal, or food selection, results in increased consumption (see Renner, 1944, for early work,

and Hetherington, Foster, Newman, Anderson, & Norton, 2006; Sørensen, Møller, Flint, Martens, & Raben, 2003; and Wadhwa & Capaldi-Phillips, 2014, for more recent reviews). Variety within a meal (regarding the components holistically, not specific sensory attributes within the same food product or category) can be determined in several ways, for instance, as the number of unique items, as the mix of unique items, and as a pairwise difference between items. It is worth noting that the way in which the items are presented affects the *perceived variety* and that this (the perceived, but not the actual variety) can also affect consumption. For instance,

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Levitsky, Iyer, and Pacanowski (2012) observed that the energy intake was lower when they presented mixed pasta and stir-fry vegetables than when the two components were presented separately, thus suggesting that segregating food into discrete units increases energy intake by increasing the perceived variety of foods that are available for consumption (see also Redden & Hoch, 2009). Variety can also be presented within the same food category; that is, by presenting systematic alternations of specific sensory attributes, such as the texture, the flavour, or the colour, of a single product category (e.g., as found in a flavoured yoghurt assortment pack).

People eat more when given a variety of different foods to choose from in a meal setting, as compared to when they are given only a single foodstuff to consume (see Epstein, Temple, Roemmich, & Bouton, 2009; Rolls, Rolls, & Rowe, 1982a; Rolls, Rowe, & Rolls, 1982c; Rolls, Rowe, et al., 1981). Several different mechanisms have been put forward to account for this behavioural change. In the context of marketing, the three underlying mechanisms for variety-seeking behaviour that have been outlined are: Curiosity (a cognitive response), boredom (with the choice process), and attribute satiation (a sensory perceptual response; see Van Trijp, Hoyer, & Inman, 1996). It could be argued that within the context of a meal, these mechanisms (and particularly the latter two) are more closely interrelated (since they influence behaviour over a narrower timeframe; that is, over minutes or hours rather than over weeks or months). These two concepts, together with other closely related phenomena, will be described in this introductory section (see Haws & Redden, 2013, for an account of consumers' self-control). These are an essential contribution to the understanding of the effect that colour has on consumption behaviour in humans, which is the topic that will be covered in the main body of this review.

Boredom

'Boredom' is frequently mentioned as a cause of low, or declining, consumption for those products that were once, initially, (highly) accepted. That said, Zandstra, Weegels, Van Spronsen, and Klerk (2004) argue that it is not always clear what is meant by this complex concept, since the specific definition of boredom would appear to vary from one researcher to the next. Furthermore, as yet, no standard method of measuring boredom has been developed. In the literature, boredom has often been studied via exposure testing. This involves the repeated consumption of a product over a period of weeks or months, although some researchers have observed boredom with the multiple alternations of the foods within a meal (Brondel, Lauraine, et al., 2009).

Zandstra et al. defined two distinct types of boredom: One is boredom with the product, which is thought to be a neural/physiological response resulting in a decrease in actual *liking* attributable to a consumer's satiation with specific attributes of the food that has been consumed (a response that encompasses *sensory-specific satiety* – SSS, described below). The second type of boredom is with the concept. This is more of a cognitive response, involving, as it does, a decrease in the *desire* to eat a specific food repeatedly. Therefore, it could be argued that SSS constitutes a part of the liking dimension of boredom. In order to illustrate the difference between boredom (with the concept) and SSS, let's take an example from an experiment reported by Zandstra, de Graaf, and Van Trijp (2000). In this study, three different groups of participants consumed a meat sauce once a week for dinner at home over a period of 10 weeks. The 'monotony' group received the same flavour of meat sauce for the duration of the entire study; an 'imposed variation' group received one of three different flavours of meat sauce each week in a random order, while the 'free choice' group were allowed to pick any one of the three flavours of the meat sauce

each week. In the monotony group, an increase in boredom was observed together with a decline in people's acceptance ratings, thus supporting the idea that specific product attributes can change long-term consumer preferences. However, those participants in the imposed variation group reported being more bored with the food than in the free-choice group. This result would appear to indicate that boredom with the product (note that the authors also refer to this as SSS, Zandstra et al., 2000) is not only influenced by the specific sensory attributes of the food itself, but also by psychological and situational factors beyond sensory and hedonic determinants.

Sensory-specific satiety (SSS)

As mentioned in the earlier section, SSS constitutes a part of boredom with the product (which involves repeated exposure). The term SSS is typically used in order to refer to the decrease in the pleasantness of a food that results from eating that food (*ad libitum* or to satiation), with a lower decrease in the pleasantness of other foods that have not been consumed (or eaten to satiation) within the meal (Hetherington & Rolls, 1996; Hetherington, Rolls, & Burley, 1989; Rolls, 1985). This means that people become satiated with specific foods after having been presented with them (and typically consuming them) repeatedly, and hence start to find the food less appealing/pleasant. Note here that chewing without swallowing has also been shown to give rise to significant SSS effects, thus demonstrating that actual consumption of the food is not actually a necessary prerequisite when it comes to eliciting the effect (e.g., Nolan & Hetherington, 2009; Rolls & Rolls, 1997; Smeets & Westerterp-Plantenga, 2006).¹

In addition, Higgs, Williamson, and Attwood (2008) have demonstrated that it is not necessary to remember having eaten a food in order to exhibit SSS to that food. In their study, they tested whether two densely amnesic patients with bilateral damage to the medial temporal lobes (who lacked memory for recent eating) would report SSS, comparing the results to a control group ($n = 8$). The results showed a decline in the rated liking of a food consumed to satiety from both groups, whereas only the amnesic patients showed hyperphagia (abnormal appetite and excessive ingestion of food). This finding seems to suggest that cognitive processes based on memories of having eaten do not underlie SSS (though memories of what has been eaten on the day have been shown to inhibit participants' subsequent consumption of snacks, relative to their consumption in a condition in which the participants were asked to recall the lunch eaten on the previous day or other non-food related memories; Higgs, 2002, 2008).

To date, many studies have focused on the effect of SSS on the intake of consumers from a holistic point of view. One consequence of SSS is that people will, for instance, typically eat less of a given food if it is presented by itself than if it is presented together with a selection of other foods (e.g., Brondel, Romer, et al., 2009). Other studies, meanwhile, have either focused on the consumption of micronutrients or macronutrients instead (e.g., protein, carbohydrates; e.g., see Johnson & Vickers, 1992; Vandewater & Vickers, 1996). Several studies have demonstrated the contribution made by the individual sensory parameters that influence the perception of food in humans. Researchers have, for instance, explored the effect of the texture (Guinard & Brun, 1998), odour (Guinard, Caussin, Campo Arribas, & Meier, 2002; Rolls & Rolls, 1997), flavour (Maier, Vickers, & Jeffrey Inman, 2007; Romer et al., 2006), and, ultimately,

¹ Note that SSS is related to *alliesthesia*, the phenomenon by which sensory stimuli can arouse pleasant or unpleasant sensations according to the internal state of a person, such as the hunger state (Jiang et al., 2008). So, for instance, the same food can be rated as either pleasant or unpleasant depending on whether a person is hungry or satiated, leading to positive or negative alliesthesia, respectively).

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