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More than meets the mouth: Assessing the impact of the extrinsic factors on the multisensory perception of food products

PhD Thesis

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‘Cheshire Puss, ... would you tell me, please, which way I ought to go from here?’
‘That depends a good deal on where you want to get to,’ said the Cat.
‘I don’t much care where--’ said Alice.
‘Then it doesn’t matter which way you go,’ said the Cat.
‘--so long as I get SOMEWHERE,’ Alice added as an explanation.
‘Oh, you’re sure to do that,’ said the Cat, ‘if you only walk long enough.’

‘In THAT direction,' the Cat said, waving its right paw round, ‘lives a Hatter: and in THAT direction,' waving the other paw, ‘lives a March Hare. Visit either you like: they're both mad.'
‘But I don't want to go among mad people,' Alice remarked.
‘Oh, you can't help that,' said the Cat: ‘we're all mad here. I'm mad. You're mad.'
‘How do you know I'm mad?' said Alice.
‘You must be,' said the Cat, ‘or you wouldn't have come here.'

Lewis Caroll, Alice's Adventures in Wonderland

Summary

Consumers' perception and response to a food product has been widely studied by many research disciplines. It is a complex process that is determined by the interaction of a number of factors which may be classified as belonging mainly to the product itself, to the consumer, and to the situation (or context).

In a given context, our perception of a stimulus (in this context, a food product) is affected, first, by its various sensory properties (both product extrinsic and product intrinsic cues). The intrinsic characteristics of a food (such as its taste, smell, colour, texture, and sound, etc.) obviously play a key role in the evaluation of consumer products. However, food is never presented in isolation, that is, it is always delivered to the final consumer in a package (as found in supermarkets), or with tableware (as in the case of a restaurant, or household context). It is important to consider that these other extrinsic elements also generate expectations concerning the properties of food (e.g., taste, texture, quality, etc.).

Most of the research found on the impact of extrinsic factors is focused on the expectations evoked by the colours, the written information, the labeling, and the brand of packaged products. However, the evaluation of a food, at both sensory-discriminative and affective levels, may well also be influenced by the many other sensory characteristics of a package, as well as by those of the tableware used. This impact has not been explored in any depth from a multisensory or crossmodal approach before.

The present thesis aims to address this gap in the knowledge base and investigate how the different senses interact during the consumption of a food or drink, and, more precisely, how the sensory information that we receive through these external elements affects our gustatory perception and overall acceptance of a food. Each study included in this thesis explores our multisensory perception of food analyzing the interaction between different modalities –primarily vision, touch, and taste– that are involved in the process. To that end, the experimental work has been approached using a range of techniques from disciplines such as psychophysics, sociology, sensory science, and marketing (e.g., implicit association task (IAT), free word association task, different types of questionnaires). The results are explained in an

interdisciplinary framework, combining knowledge and theories in areas such as perceptual psychology, sensory science, consumer research, and design. Overall, the results show how complex is the multisensory perception of a food (along with the accompanying items for its consumption), as well as its measurement and interpretation.

This work has been carried out following the official procedure for the completion of an International PhD. During the course of the PhD, the candidate performed a large number of research studies in the Department of Experimental Psychology at the University of Oxford (Oxford, UK) for a period of six months. Moreover, the body of this thesis consists in a compilation of publications, in accordance with the requirements established by the Universitat Politècnica de València (Valencia, Spain). It includes ten articles published in international indexed journals.

Resumen

La percepción de los consumidores y su respuesta a un producto alimenticio ha sido ampliamente estudiada a través de numerosas disciplinas de investigación. Es un proceso complejo que está determinado por la interacción de una serie de factores que pueden ser clasificados principalmente como pertenecientes al producto en sí, al consumidor, y a la situación.

En un contexto dado, nuestra percepción de un estímulo (en el presente marco, un producto alimenticio) se ve afectada, en primer lugar, por sus diversas propiedades sensoriales (extrínsecas e intrínsecas). Las características intrínsecas de un alimento (por ejemplo su sabor, olor, color, textura, emisión de sonido al romperse, etc.) obviamente desempañan un papel esencial en su evaluación por parte de los consumidores. Sin embargo, la comida nunca se presenta de forma aislada; normalmente se presenta a los consumidores envasada (como se encuentra en los supermercados), o junto con otros artículos de mesa (como en el caso de un restaurante, o el contexto del hogar). Es importante considerar que estos otros elementos extrínsecos también generan expectativas sobre las propiedades de los alimentos (por ejemplo sabor, textura, calidad, etc.).

La mayor parte de investigación sobre el impacto de los factores extrínsecos se centra en las expectativas evocadas por los colores, la información escrita, el etiquetado del envase y la marca de los productos envasados. Sin embargo, el impacto que puede llegar a producir tanto los envases como la cubertería o vajilla empleada en la evaluación de un alimento, a un nivel tanto sensorial como afectivo, ha sido poco explorado desde un enfoque multisensorial.

La presente tesis tiene como finalidad cubrir dicha área de conocimiento e investigar cómo los distintos sentidos interactúan durante el consumo de un alimento o bebida, y más precisamente, cómo la información sensorial que recibimos a través de los elementos externos al alimento influye en nuestra percepción gustativa y hedónica del mismo. Cada estudio comprendido en esta memoria explora nuestra percepción multisensorial de los alimentos analizando la interacción entre distintas modalidades –principalmente entre la visión, el tacto y el gusto– que intervienen en el proceso. Para ello se han empleado diversas técnicas provenientes de disciplinas como la psicofísica, sociología,

ciencia sensorial y *marketing* (por ejemplo, tarea de asociaciones implícitas (IAT), asociación libre de palabras, distintos tipos de cuestionarios, etc.). Los resultados obtenidos se explican en un marco interdisciplinar, combinando conocimientos y teorías de áreas como la psicología perceptiva, la ciencia sensorial, la investigación con consumidores, y el diseño. En conjunto, los resultados demuestran la complejidad de la percepción multisensorial de un alimento (junto con los elementos que lo acompañan durante el consumo), así como la de su medida e interpretación.

Este trabajo ha sido llevado a cabo siguiendo el procedimiento oficial para la realización de un doctorado con Mención Internacional. Durante el transcurso del doctorado, la candidata ha realizado una parte de la investigación en el Departamento de Psicología Experimental de la Universidad de Oxford (Oxford, Reino Unido) por un periodo de seis meses. Por otra parte, esta tesis doctoral se ha elaborado de acuerdo con los requisitos establecidos por la Universitat Politècnica de València (Valencia, España), para las tesis presentadas por compendio de publicaciones, incluyendo diez artículos publicados en revistas internacionales indexadas.

Resum

La percepció dels consumidors i la seva resposta a un producte alimentari ha sigut àmpliament estudiada a través de nombroses disciplines de recerca. És un procés complex que està determinat per la interacció d'una sèrie de factors que poden ser classificats principalment com pertanyents al producte en si, el consumidor, i a la situació.

En un context donat, la nostra percepció d'un estímul (en aquest marc, un producte alimentari) es veu afectada, en primer lloc, per les seves diverses propietats sensorials (extrínseques i intrínseques). Les característiques intrínseques d'un aliment (per exemple, el seu color, textura, olor, so, etc.) òbviament tenen un paper essencial en l'avaluació de productes dels consumidors. No obstant això, el menjar mai es presenta de forma aïllada, és a dir, sempre es presenta als consumidors envasada (com es troba als supermercats), o juntament amb altres articles de taula (com en el cas d'un restaurant, o el context de la llar). És important considerar que aquests altres elements extrínsecs també generen expectatives sobre les propietats dels aliments (per exemple, sabor, textura, qualitat, etc.). La majoria d'investigacions trobades sobre l'impacte dels factors extrínsecs es centren en les expectatives evocades pels colors, la informació escrita, l'etiquetatge de l'envàs i la marca dels productes envasats. No obstant això, l'impacte que poden arribar a assolir (tant els envasos com la coberteria o vaixella emprada) en l'avaluació d'un aliment, a un nivell tant sensorial com afectiu, han sigut poc explorats des d'un enfocament multisensorial.

Aquesta tesi té com a finalitat cobrir aquesta àrea de coneixement i investigar com els diferents sentits interactuen durant la consumició d'un aliment o beguda, i més precisament, com la informació sensorial que rebem a través dels elements externs a l'aliment influeix en la nostra percepció gustativa i hedònica d'aquest. Cada estudi comprès en aquest treball explora la nostra percepció multisensorial dels aliments analitzant la interacció entre diferents modalitats, principalment entre la visió, el tacte, i el gust, que intervenen en el procés. Per això s'han emprat diverses tècniques provinents de disciplines com la psicofísica, sociologia, ciència sensorial i màrqueting (ex., tasca d'associacions implícites (IAT), associació lliure de paraules, diferents tipus de qüestionaris,

etc.). Els resultats obtinguts s'expliquen en un marc interdisciplinari, combinant coneixements i teories d'àrees com la psicologia perceptiva, la ciència sensorial, la investigació amb consumidors, i el disseny. En conjunt, els resultats demostren la complexitat de la percepció multisensorial d'un aliment (juntament amb els elements que l'acompanyen durant el consum), i també la seva mesura i interpretació.

Aquest treball ha sigut dut a terme seguint el procediment oficial per a la realització d'un doctorat amb Menció Internacional. Durant el transcurs de la tesi doctoral, la candidata ha fet una part dels treballs d'investigació en el Departament de Psicologia Experimental de la Universitat d'Oxford (Oxford, Regne Unit) per un període de sis mesos. D'altra banda, aquesta tesi doctoral s'ha elaborat d'acord amb els requisits de la Universitat Politècnica de València (València, Espanya), per a les tesis presentades per compendi de publicacions, incloent deu articles publicats en revistes internacionals indexades.

1 General introduction

Starting point of the thesis

As irrational as it might sound, a high percentage of consumers find that their daily brew tastes better from their favourite mug. Perhaps that drink, which is always prepared in more or less the same manner, does not <u>really</u> taste better from that preferred mug, but the mug itself simply improves the consumer's overall multisensory experience. This anecdote is but one example highlighting the relevance of studying more in detail the impact that the surrounding elements in which food and drinks are delivered or served (e.g., packaging and tableware) have on consumers' perception of food and beverages, and their overall consumption experience.

Consumer perception: A quick overview

The perception and response of consumers to a food product has been widely studied across many research disciplines. It is a complex process that is determined by the interaction of a range of factors that can mainly be categorised as belonging to either the product itself, to the consumer, or to the context or situation. These three main factors interact throughout the entire perceptual process.

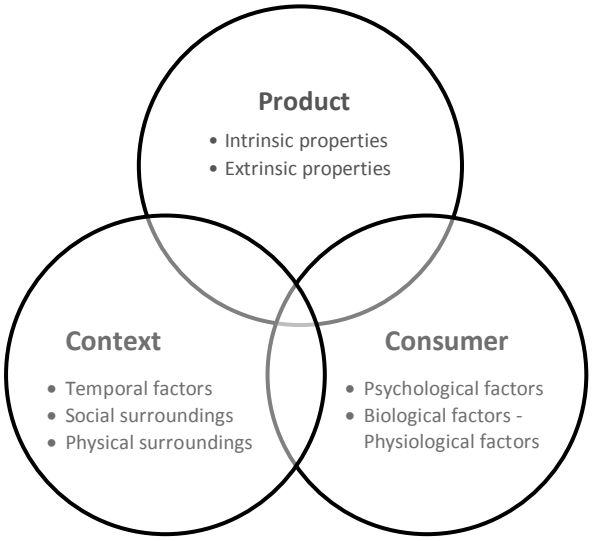

Figure 1.1. Scheme of the main factors that influence consumer perception of food products.

In a given context, our perception of a stimulus (in this framework, a food/ drink product) is firstly affected by its various sensory properties (both intrinsic, referring to

those of the food itself, and extrinsic, this is, those of the elements surrounding the food). However, we do not process all of the information that happens to be present; in fact, only a very small proportion of the available stimuli is noticed, and even a smaller number is attended to. The filtering of information, the attention paid to it, and its interpretation is influenced by the consumer's unique bias, based on his / her own needs, experiences, and motivations. This is the process that could be defined as *perception.*

The perceptual process

According to Schiffman, Kanuk, and Hansen (2008), consumer perception has four elements: sensation, absolute threshold, differential threshold, and subliminal perception. These basic phenomena will be briefly explained in this section. The process starts when the sensory receptors receive the sensory input. Then they produce an immediate response to the stimuli, which is called *sensation* (i.e., seeing, smelling, hearing, tasting, and feeling). The strength of the sensation depends on the intensity of the sensory input as well as on the capacity of the consumer's sensory receptors. However, as exposure to a stimulus increases, the ability to notice it decreases because the sensory receptors get "used to it" and adapt to that particular level of stimulation. This sensory mechanism is referred to as *sensory adaptation* and the level at which we stop detecting the sensation produced by a given stimuli is called the *absolute threshold,* which increases under conditions of constant stimulation. That is the reason why after being in a fragranced room for some minutes, we are not able to smell the odour anymore. To be able to detect again the odour, we would need the stimulation to stop, a higher level of stimulation, or another source of stimulation (e.g., another fragrance). Continuing with the example, in the case that another odour was used, for the olfactory receptors to notice the difference between the first and the second odours, the intensity of the latter one would have to be over the *differential threshold*, which is defined as the minimum difference that can be detected between levels of two similar stimuli (also called the "just noticeable difference").

It is important to highlight here that although most stimuli are perceived above our level of conscious awareness, weak or brief (i.e., sub-threshold) stimuli can still be perceived by one or more receptor cells without us being conscious of it (so we perceive it "subliminally"). This unconscious type of perception is also known as *subliminal perception*.

Regarding the dynamics of perception, it is commonly divided in three steps: selection, organization, and interpretation. Consumers are exposed to hundreds of messages each day; however, they subconsciously select the stimuli they want to perceive, that is, their brain often "filters out" information. This selection is based on previous experience (which creates expectations about the stimuli) and their motives (e.g., an unexpected element, or attribute of a product, always attracts attention, be it a certain flavour of a food, the colour of a drink -or even that of its package). Hence they select what they are being exposed to (in the first place) and what they want to pay attention to or focus on.

It could be said, then, that the brain assembles distinct elements from less than complete information. In the perception of these elements, there are certain organising principles which are based on Gestalt psychology. The Gestalt approach to perception holds that psychological, physiological, and behavioural phenomena are irreducible experiential patterns that cannot be derived from a simple summation of perceptual elements, such as sensation and response. Some of these principles are figure-ground segregation, grouping, and closure (see Spence, Sanabria, & Soto-Faraco, 2007). Finally, consumers interpret the stimuli subjectively based on previous experiences, on expectations, on motives and interests, and on the clarity of the stimulus itself. The most common reasons which explain why consumers do not perceive stimuli in an objective way include expectations, physical appearances, stereotypes, first impressions, jumping to conclusions, and halo effects. The latter one is particularly interesting in the framework of the present thesis. It is observed when the attributes of one factor are transferred to another in such a way that it affects the judgement of the product. A similar notion it that of a heuristic evaluation, which is an evaluation based on extraneous factors (e.g., evaluating the quality of a perfume based on the weight of its bottle). Some of these concepts will be discussed further in the next chapters.

Figure 1.2 depicts the basic stages of the perceptual process of food products.

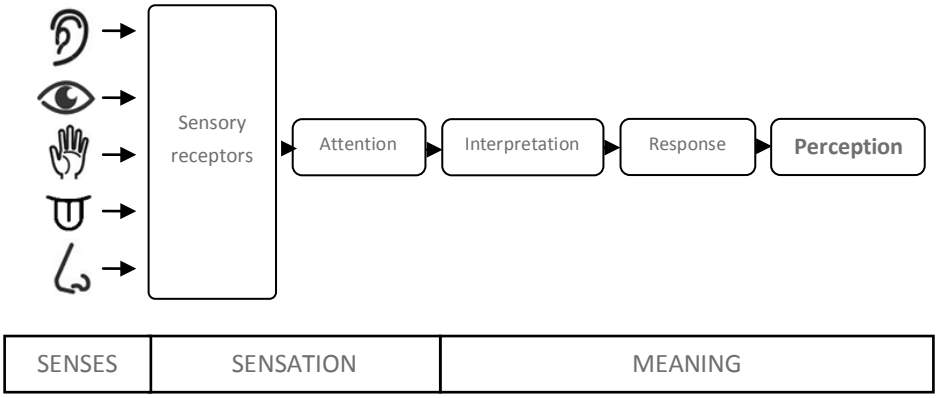

Figure 1.2. Basic model of the perception of food products [adapted from Solomon, Barmossy, Askegaards, & Hogg, 2006, p. 37)].

In the framework of this thesis, a better way in which to understand how food is perceived is by including in the model the cognitive sequential processing of multisensory integration (MSI) of food properties. Figure 1.3 illustrates the processing as described by Verhagen and Engelen (2006), represented in separate neural structures and followed by pre-attentive MSI and conscious perception. A more detailed description of how this integration takes place will be given in the sections that follow.

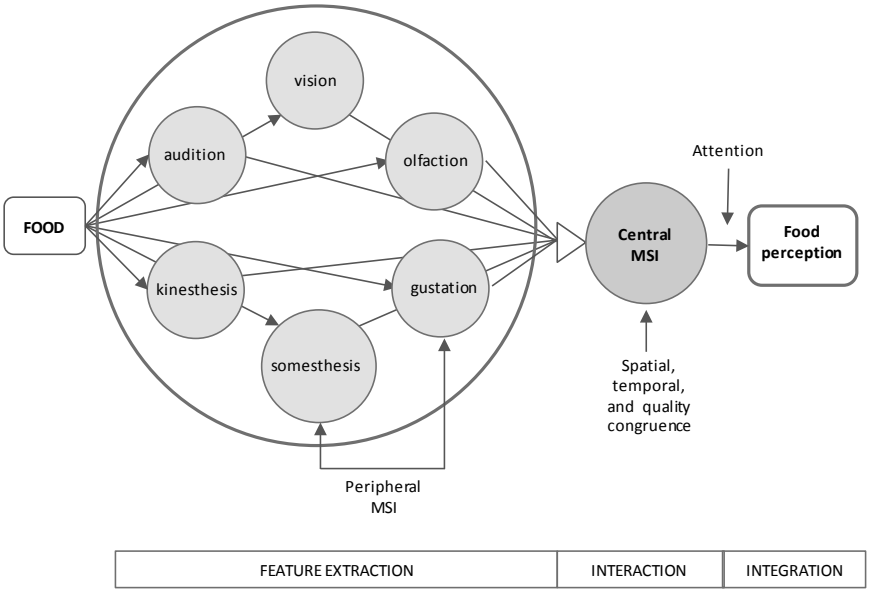

Figure 1.3. Cognitive model of food perception [adapted from Verhagen and Engelen (2006)].

Multisensory food perception

When thinking about how we perceive a food product, a popular association that first comes to mind is that of flavour perception. However, there is an on-going debate around the definition of the term flavour, and what senses intervene in its perception. In fact, flavour perception is a multisensory experience, and hence it could be considered as a perceptual modality, rather than a sensory modality (Auvray & Spence, 2008; Gibson, 1966; Spence, Auvray, & Smith, submitted).

According to the International Standards Organisation, flavour is defined as the "*complex combination of the olfactory, gustatory and trigeminal sensations perceived during tasting. The flavour may be influenced by tactile, thermal, painful and/or kinaesthetic effects."* (ISO 5492, 2008). So, according to this definition, flavour perception arises from the unified oral sensation of taste and smell (both orthonasal and retronasal (Lawless, 2001, Murphy, Cain, & Bartoshuk, 1977) and also oral-somatosensory qualities of foods, such as their texture, temperature, and even their ability to elicit painful sensations (Christensen, 1984; Lawless Rozin, & Shenker, 1985; Stevenson, 2009; Szczesniak, 2002). That is, gustatory, olfactory, trigeminal, and oral-somatosensory cues would be the only senses that contribute directly to the perception of flavour. However, the sounds that we make and hear while eating can also influence our perception of the texture of crunchy foods (see Spence, in press; Spence & Shankar, 2010; Spence & Zampini, 2006, for reviews). These four interoceptive sensory inputs are combined through multisensory integration to deliver flavour perception (Spence, 2012).

What is more, visual cues, primarily those related to a food's colour, exert a profound effect on consumers' perception of the identity and, to a lesser extent, the intensity of a food's taste and flavour (see Spence *et al.*, 2010, for a review). In addition, the sound the food may produce while being handled (together with the feeling of its texture in our hands), and the smell it releases can also influence flavour perception. These four other cues (namely visual, orthonasal olfactory, distal auditory, and tactile), referred to as exteroceptive cues, or flavour expectancy cues (Stevenson, 2009), do so by another mechanism. Given that, in the majority of cases these cues are available prior to the food's consumption, they typically provide the greatest contributions in terms of our expectations about its likely texture, aroma, and/ or taste. Hence, these other senses also play an important contributory role in terms of flavour perception (Shankar, Levitan, & Spence, 2010).

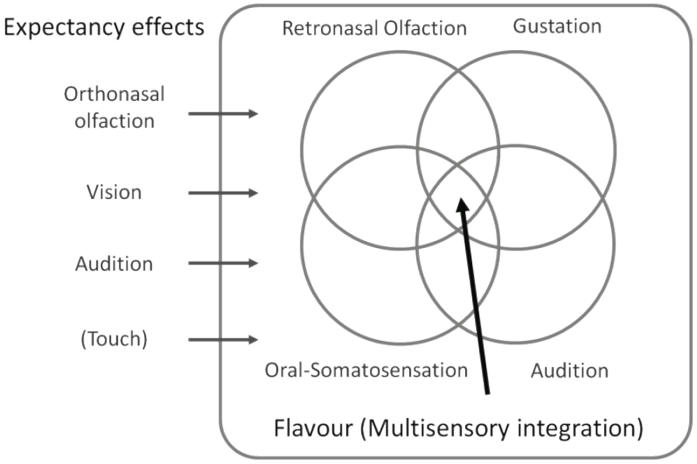

Figure 1.4. Distal (or exteroceptive) senses and proximal (or interoceptive) senses influence multisensory flavour perception.

Crossmodal interactions

The individual contribution of each of the senses to our perception of food cannot be easily quantified, since, when we consume food, all of the senses are involved, which entails the simultaneous perception of different sensations, such as taste, aroma, texture, heat, etc. However, to avoid information overload, the brain uses certain rules to integrate and interpret the sensory inputs in ways that are not always predictable. For instance, certain sensory attributes of a product perceived via one or more modalities (such as vision and touch) can bias a consumer's perception of other attributes of that product derived from other sensory modalities into alignment, and consequently, modulate a person's overall (multisensory) consumption experience. These interactions of the senses are referred to as *crossmodal* (or *multisensory*) *interactions*. For instance, one robust finding from psychophysical research on multisensory flavour perception is that odours can elicit changes in the perceived sweetness (i.e., taste) of foods (e.g., Stevenson & Boakes, 2004; Stevenson, Prescott, & Boakes, 1999). In addition, the ability to identify odours and tastes has been demonstrated to be weakened when they are presented without colour cues or when paired with an inappropriate colour (e.g., Blackwell, 1995; Zellner & Kautz, 1990; see also Clydesdale, 1984, 1993, for reviews; Spence, Levitan, Shankar, & Zampini, 2010). It has also been shown that even experts can easily be tricked by their senses: For instance, Morrot, Brochet, and Dubourdieu (2001) reported that a group of oenologists

chose red wine odour terms to describe certain white wines which were artificially coloured red. This finding has been replicated in numerous other experiments.

These interactions entail that some senses dominate over others in the perceptual process. Which sense dominates over others not only depends on the product, but also on the type and aim of the interaction with the product (Schifferstein, 2006), and also on the unique characteristics of the consumer (e.g., whether we are supertasters or not, Bajec & Pickering, 2008; Bartoshuk, Duffy, & Miller, 1994; see also Peck & Childers, 2003). What happens is that our brains typically use the most accurate sense to dominate our multisensory perception (Spence & Gallace, 2011), and that the interpretation of more ambiguous sensory information receives less weight in the formation of judgments (Ernst & Bülthoff, 2004). This falls under the cognitive neuroscience notion of *sensory dominance*. In many (most) cases, it is vision that provides us with the most accurate information about the objects around us. Moreover, vision is likely to have an even larger impact on product experiences than the other senses because visual information is processed more quickly and is typically available sooner. For example, we typically see a product on the shelf before we decide to pick it up, and we inspect the food on our plates before we decide what to eat next (see Spence, 2010; Spence, Levitan, Shankar, & Zampini, 2010, for reviews).

It is worth highlighting that sensory dominance is a dynamic process. That is, the dominance of one sense or the other may vary throughout the different stages of one's interaction with a product (Fenko, Schifferstein, & Hekkert, 2009). This concept does not have to be mistaken by the relative importance given to the different senses, which is related to attention and to the use of the most appropriate modality depending on the unimodal capability required for a given stage of interaction (as when we concentrate in a wine's aroma to identify certain notes).

Sensory incongruity

Sensory congruency in the food and beverage sector could be defined here as occurring when the sensory features present in one modality (e.g., vision) match (that is, agree with) the sensory features present (or expected) in a different sensory modality (or in different modalities), as perceived by the majority of those individuals who are likely to come across a particular food product. When a mismatch occurs (and is noticed, i.e., there is no sensory dominance taking place), then sensory incongruity is perceived instead. In this latter case, there is likely to be a 'disconfirmation of expectation', which can lead to reactions such as surprise, or even disgust. Whether

the reactions elicited are positive or negative depends on the degree of incongruity, the familiarity with the food, the personal characteristics of the consumer (e.g., Ludden, Schifferstein, & Hekkert, 2012; Piqueras-Fiszman & Spence, 2012; Schifferstein, 2001; Yeomans, Chambers, Blumenthal, & Blake, 2008). An intermediate perceptual stage between sensory dominance and sensory incongruity would result in the consumer not being able to identify accurately the properties of the second stimuli perceived.

Crossmodal correspondences

Through their experiences with foods, consumers build up ideas about which types of sensory stimuli tend to co-occur and which do not (e.g., a red coloured fruit will be more likely to be sweeter than a green one, for instance; Maga, 1974). They develop an associative mechanism through repeated exposure to particular combinations of stimuli, which form the basis of the correspondences that people perceive across different sensory modalities. If certain pairs of sensory stimuli are more likely to be found together for a consumer, they would match better (and hence become congruent) in his/ her mind. What is more, presenting one of the stimuli by itself may increase that consumer's expectation that the other stimulus should also be present (see Garber, Hyatt, & Starr, 2001; Schifferstein, 2001). If another stimulus is present instead of the one expected (associated) then the resulting combination would be considered as being incongruent. Besides these associations (formed through prior experience), people might perceive some closeness (or correspondence) among colours, sounds, tastes, smells, and other sensory stimuli directly, because certain dimensions of sensory experience are shared across the different sensory modalities, such as intensity (weak-strong), duration, and spatial location (Boring, 1942). For example, a drink (or even its packaging) that has a darker (or more saturated) colour as compared to another one, would be associated with a stronger taste or effect (e.g., Becker, Van Rompay, Schifferstein, & Galetzka, 2011).

The food product: Intrinsic and extrinsic properties

The *intrinsic properties* of a product are defined here as those physical and sensory qualities belonging to the food or beverage itself (e.g., its colour, texture, smell, sound, etc.). Intrinsic characteristics obviously play an essential role in consumers' product appraisals. Sensory scientists and food technologists are striving to innovate in their products' formulation to possibly transfer the optimal multisensory experience in every bite of food. However, food is never presented in isolation. That is, it is always

presented to consumers packed in a container (as found in supermarkets), or served on a plate, bowl, cup, etc., accompanied by other tableware (as in the case of a restaurant / home context) under certain background sound and lighting conditions. While the intrinsic properties of foods provide valuable information to evaluate the food, it is important to consider that they are only ever a part of the overall product evaluation. The food product's *extrinsic properties* (the "everything else") also provide important information that give rise to expectations about the likely properties of the food within (e.g., taste, texture, quality, etc.), and that can intervene in the food product's choice, evaluation (both at sensory-discriminative and affective levels), and overall consumption experience nearly as much as the intrinsic properties (e.g., Deliza & MacFie, 1996; Krishna & Morrin, 2008; Schifferstein, 2009). In particular, a great deal of research has been carried out on packaging regarding the expectations evoked by its colours (e.g., Ares & Deliza, 2010), written information (e.g., Cardello & Sawyer, 1992; Carrillo, Varela, & Fiszman, 2012), labelling (e.g., Deliza & MacFie, 1996; Tuorila, Cardello, & Leshser, 1994), and branding, and their influence on consumers' choice.

Underlying effects

In terms of understanding the effects of these extrinsic elements on our perception and evaluation of food, there appears to be a number of potentially relevant psychological and physiological explanations that have been documented. Given that these cues do not come from the food itself, they could be considered as being non-diagnostic (i.e., that objectively should not identify or prompt any effect in our perception of food). Hence crossmodal correspondences observed between the intrinsic and extrinsic elements of a food product could be regarded as examples of *sensation transference* (Cheskin, 1957; Schifferstein, 2009). What is more, given that sensory perception is intrinsically related to hedonism, the hedonic attributes of a product perceived via one sensory modality can also bias a consumer's appraisal of the quality and pleasantness of a multisensory product as experienced by other sensory modalities (Spence & Gallace, 2011). This effect, known as '*affective ventriloquism*', could therefore be thought of as a specific (i.e., hedonic) form of sensation transference, or heuristic evaluation.

It is also very likely to encounter *perceptual illusions* between the food (front) and plate or bowl (background). For instance, the Ebbinghaus-Tichener size-contrast illusion (or the Delboeuf illusion) explains why the same amount of food is perceived as more filing when eaten from a small bowl compared to a larger bowl (van Ittersum &

Wansink, 2012). Lyman (1989) and Hutchings (1994) stated that effects derived from perceptual visual illusions, such as colour contrast, could be observed in the context of food presented on a plate, but would our oral perception of the food be affected too? Similarly, *psycholinguistic transference* might result in descriptions of cutlery, plates, cups, or decorations to be transferred onto the food (e.g. a "heavy" bowl results in the perception of heavy food). High-level attributes of the accessories, such as their perceived quality and expense, might be transferred to the consumables, just as low-level attributes (such as colour) appear to be (Harrar, Piqueras-Fiszman, & Spence, 2011).

However, when measuring these crossmodal correspondences in psychophysical tests with questionnaires, effects such as 'halo', 'dumping', and those produced by the context or the experimental protocol should be considered, since they can influence responses (Churchill, Meyners, Griffiths, & Bailey, 2009). As mentioned earlier, the halo effect occurs when a general impression of a stimulus biases (in a positively correlated way) its evaluation on supposedly unrelated characteristics (Asch, 1946). A related principle is that of dumping. This occurs if the considered list of attributes on which to rate the food does not sufficiently cover all observed perceptions or judgments. Panellists then "dump" their assessment on to one or more attributes that are present/ available. This results in an artificial enhancement of scores on other scales (Lawless & Clark, 1992; Clark & Lawless, 1994). Together, these types of effects should be taken into account when drawing conclusions of the results obtained; however, it is not always evident whether these effects (and which) have biased the participants ratings.

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2 Rationale and objectives

Rationale

As mentioned in the Introduction, the food product's extrinsic properties may not only provide important information that give rise to expectations about the likely properties of the food within, but also intervene in the food product's choice, evaluation, and overall consumption experience nearly as much as the intrinsic properties. A great deal of research has been carried out applied to packaging regarding the expectations evoked by its colours (e.g., Ares & Deliza, 2010), written information (e.g., Cardello & Sawyer, 1992; Carrillo, Varela, & Fiszman, 2012), labelling (e.g., Deliza & MacFie, 1996; Tuorila, Cardello, & Leshser, 1994), and branding, and their influence on consumers' choice. However, the effects of the extrinsic elements on our perception of food, from a multisensory approach, have been much less studied: Not much has been investigated around the shapes and colours of the elements of the label, the shape of the package, its texture, colour, and so on. As mentioned above, they might not only convey, but also *affect our sensory perception and judgments* of the food. In fact, changing any one of the sensory attributes of the packaging (be it the appearance, what it sounds like, how it feels in the hand, or even what it smells/tastes like) can alter a consumer's product perception. The truth is that similar effects can then be observed with tableware. However, currently little is known about the extent to which the multisensory aspects of non-edible items associated with eating and drinking may affect people's perception of foods.

Objectives

The aim of the research reported in this thesis was to investigate how, and to what extent, the various sensory attributes of the extrinsic elements of foods (e.g., a package or tableware in which the food is presented, and/ or consumed from) can influence our expectations and perception of food (both sensory-discriminative and hedonic).

More specific aims were:

To explore general *associations* elicited from labels consisting of distinct sets of graphic elements; and also those between particular sensory attributes of a certain packaging and the properties (sensory, hedonic, and/ or quality-related) of the food within.

To investigate the *effects* that modifying different sensory attributes of the extrinsic elements –namely visual and/ or haptic attributes– have on consumers' gustatory perception, acceptance, and quality appraisal of a given food or beverage.

To investigate whether *abstract attributes*, such as quality, that the sensory properties of extrinsic elements may convey to consumers can be transferred to the food consumed.

To use a *variety of experimental procedures* which would enable to better explore how the senses interact to affect consumers' behavioural and hedonic response to, and sensory perception of, various food and drink stimuli.

To approach the results from a *multidisciplinary perspective* which would provide deeper insights and a more complete explanation of how crossmodal interactions between the food and the items that accompany it can influence our multisensory consumption experience.

This text represents a modest attempt to put some of these developments in perspective, maybe not as many as the author would have wished for, but nonetheless a start.

Thesis outline

The main body of the thesis comprises a compilation of publications in international journals. Chapters 2-5 explore associations or beliefs that consumers hold or elicit, prior to consuming the food product, while Chapters 6-11 explore the direct effect of these associations on the perception of food (i.e., at the moment of consumption).

General and crossmodal associations and expectations

To start with, Chapter 3 introduces a number of general notions concerning how consumers perceive and interpret the visual elements present in a set of food packaging labels through a semiotics analysis. Two age cohorts of consumers were assessed in order to compare the meanings they attach, their global associations, and their expectations regarding the likely sensory and affective attributes of the products.

Chapter 4 investigates the associations consumers hold regarding packaging labels, but in this case focusing on crossmodal associations between colour and flavour. The acquaintance with the brand as a generator of these associations is studied by means of an adapted Implicit Association Task (IAT). Furthermore, it also examines the reactions of consumers of a given brand when tasting the flavour of a food (crisps) that is being served from a switched package (and which colour does not match with their learned association). A closer look at the possible origins of these colour-flavour associations in food packaging is given in Chapter 5. A study is described where both implicit and explicit association tasks are performed in two countries.

But consumers build an impression of a product (and attach a specific meaning or association to it) based not only on the design of the label (visual stimuli), but also on other attributes. For instance, for certain product categories, the weight of the product is commonly associated with high quality and/ or price. Chapter 6 explores the associations that consumers have regarding the weight of wine bottles to quality and price. It presents the beliefs of consumers regarding this tri-relationship and reports data collected from a winery store showing the real relationship between the weight of 500 wine bottles and their price.

Crossmodal effects on our food experience

As mentioned in the Introduction, colour plays a crucial role in how we perceive food; and our perception of a given colour greatly depends on the surrounding colour/s, among other factors. Chapter 7 describes a study which investigates how the colour of a plate influences our gustatory perception of the food placed on top by means of a perceptual illusion between the background (i.e., the plate) and the food's colour.

Chapter 8 explores the influence of the colour of a cup on our perception of flavour and aroma of a hot beverage. The perceptual mechanism observed in this case study is not based on perceptual illusions, but rather on simple crossmodal associations held between certain colours and the intensity of sensory attributes of foods or beverages.

Chapters 9 and 10 investigate the impact that the weight of the containers has on our perception of foods. Chapter 9 analyses the actual influence of the weight of the container (namely a bowl) on the sensory and affective perception of a specific food (yoghurt) in a psychophysical experiment. Psycholinguistic or semantic transfer from the haptic input of the bowl to the oral perception of the food is explored (i.e., a 'heavier' bowl may be associated with 'denser or heavier' foods). Chapter 10 takes this investigation further and addresses the question: Would visually identical foods served in bowls of different weights transmit different satiating expectations?

Chapter 11 investigates whether abstract attributes, such as quality, can also be transferred from the utensils used to the food consumed from them. The aim is to address whether the sense of higher quality that a stainless steel spoon might have in consumers' minds, in comparison to the plastic spoon, could be transmitted to the food.

Finally, Chapter 12 explores the effect that tactile cues (namely two different textures) provided in the hands (from a container) can have on our oral perception of food. It

assesses whether it affects any of the sensory textural attributes being rated or those related to the texture being felt in the hand.

Chapters 13 and 14 provide a general discussion which summarizes the insights obtained from the studies, and present some suggestions for future work and possible applications which could be potentially useful for related sectors such as nutrition, hospitality, marketing, and design.

3 Semiotics in food packaging

Semiotics and perception: Do labels convey the same messages to older and younger consumers?

Piqueras-Fiszman, B., Ares, G., & Varela, P. (2011). Semiotics and perception: Do labels convey the same messages to older and younger consumers? *Journal of Sensory Studies, 26,* 197-208.

Abstract

In this competitive world, a package has only a few seconds to make an impact and catch the consumer's eye. In that time, a successful label should communicate its message and convince the shopper. Considering the importance of transmitting an adequate, and in some occasions, the "perfect" message, it is crucial to understand how consumers perceive and interpret the labels from a semiotic perspective, which has not been considered in depth. In this context, the objective of the present study was to gather information on how consumers of different age groups read the profiles of symbolic labels and what they construe. A word association task was performed with 101 participants (50 aged below 35 years old, 51 aged 60 and over). Participants were asked to write down all that came to their minds when they saw 5 simple images of yogurt labels, which were constructed by combining a variety of signs. All the elicited terms were grouped into 54 categories, and then into 9 general dimensions. Though some main messages were conveyed successfully, relevant differences were found in perceptions and interpretations of the two age cohorts. Youngsters made more references to the specific attributes of the expected product, whereas the elders assigned more global and hedonic meanings.

Practical applications

Results of the present work contribute to knowledge of consumers' perceptions and expectations of labels and their graphic composition, which could help to better understand and predict consumers' interpretations in real situations. This can be useful for product development, ensuring that the labels and their intended meaning are not only understandable but also rapidly identifiable for all consumers. In addition, the elicited associations, imagery and lexicon, could be used to improve the design of labels and marketing campaigns to appeal to consumers of all age ranges. The differences found between the two age groups evidences the necessity to focus also on older consumers, since they are a consumer sector with real growth potential.

Keywords: Perceptions; older consumers; semiotic analysis; word association; yogurt; food labels

1. Introduction

In a general supermarket, a consumer will encounter many choices in almost every food category, with multiple flavours and styles of products being presented within each price range. This surfeit of choices forces consumers to make purchase decisions based on more than the package's content itself (Reisfelt *et al.,* 2009; Chrea *et al.,* 2011). In this context, packaging plays a crucial role in capturing consumers' attention.

Though the package has long been understood to influence consumer information processes such as attention, consideration and purchase (Moskowitz 1998; Murray & Delahunty, 2000), there is still a growing interest on the influence of package characteristics on consumer expectations of food (Moskowitz *et al.,* 2009; Ares & Deliza, 2010; Becker *et al.,* 2011; Mueller & Szolnoki, 2010). In addition, very little research has been done to grasp how the various visual elements that construct the global appearance act upon consumer behaviour from a psychological perspective. According to Köster (2009), an integrated approach directed at understanding and predicting consumer behaviour and the development of consumption patterns is still lacking, and a deeper psychological vision is needed.

It is widely known that the first visual impressions condition the package information that can be processed later and predispose ultimate actions such as choice (Garber *et al.,* 2000). According to Opperud (2004), when consumers first perceive a product the attention is drawn to signs that can help them to identify and categorize the product. In this mental process, the consumers create an opinion of what kind of product it is, what qualities it has and who the target consumer might be. All this information is gathered from the design elements or signs of the package, which include colour, symbology, typography, materials and motion. The appropriate symbolic meaning embodied in these forms depends on the researcher's and designer's capacity to decode and reproduce the common values and opinions that co-exist in society, hence the importance of delving into the fundamental mechanisms of sign interpretation.

Semiotics is the theory and study that describes signs and the mechanisms by means of which a sign system produces meaning (Kehret-Ward, 1988). According to Peirce (1931) a sign is something which stands to somebody for something in some respect or capacity. Some theorists distinguish two main levels of signification: the first level (denotative) is seen as primarily representational and relatively self-contained, this is, "literal"; the second (connotative) reflects "expressive" values which are attached to a sign. Applying the semiotic theory, a specific product design evokes thoughts,

emotions, associations, and meanings (including denotations and connotations) because they display signs that are consciously and unconsciously interpreted as such.

The cognitive prototype theory (Rosch, 1978) explains how consumers build their understanding of new products by attributing prior experiences into the perception. In this sense, the various visual signs of packages, singly and in combination, not only identify a brand, but also convey meanings in the form of associations, including metaphors and stories that are conceived in different ways by the individual consumers.

In particular, food packages and labels could communicate information to consumers in two main forms: linguistic signs (symbols based entirely on social convention), or signs that are based on resemblance (colours, shapes or pictures) (Smith *et al.,* 2010). When designing a new package, the manufacturer can borrow on the visual conventions established that connote typicality and familiarity. However, as particularly stressed in semiotics, conventions are learned through interacting with the environment and are specific to particular groups of people. In the case of the development of new formulations and products, new signs may necessarily be incorporated into consumers' knowledge, implying a learning process that relates those new signs with past experiences or expectations. For these reasons, it is essential that the repertoire of signs used convey agreed upon, shared meanings; otherwise, the communication channel would be ineffective.

Transmitting the desired meanings is a complicated process due to the array of values and standards that vary across cultures, regions, social classes and age groups. Consequently, a semiotic analysis of food packages and labels, together with a study of how consumers perceive those labels, could help to understand and interpret consumers' associations and expectations of the content, and hence to design packages that arouse specific reactions in consumers within a society.

Elderly consumers are particularly interesting to consider in a semiotic study, as they share different past experiences and traditions, which might shape their present conventions. In addition, many loose in some degree cognitive and sensory capabilities, modifying the way they perceive and interact with products (Schifferstein & Desmet, 2007). In particular, reduced visual acuity, one of incidences that increase with age (Vassilief & Dain, 1986), is important for tasks such as: seeing and reading text and identifying symbols. Reductions in visual acuity and colour perception can strongly modify the quality of the information older consumers receive, and can even affect

how they experience the product. The product experience includes its perception, the identification process it triggers, the cognitive associations and memories it arouses, the feelings and emotions it elicits and the evaluative judgments it brings about, hence the importance of ensuring an adequate interpretation from all age groups (Schifferstein & Hekkert, 2007). Furthermore, the fact that more than 25% of the population in many countries will be over 65 by 2050 (World Population Prospects, 2008) reinforces the relevance of considering older consumers in the present.

In this context, the aims of the present work were: (1) to determine if older consumers' expectations or associations raised by simulated yogurt labels, designed with different sign combinations frequently applied in commercial products, are in agreement with results from a semiotic analysis, or in other words, whether labels successfully convey what it is intended; and (2) to compare the perceptions of older consumers to those of younger adults.

2. Materials and methods

2.1. Preliminary semiotic study

In a preliminary stage, a semiotic analysis of plain yogurt labels was carried out by a team of semiotic experts and professors from the Departamento de Teoría de los Lenguajes y Ciencias de la Comunicación (Universitat de València). This analysis consisted of visualizing real commercial plain yogurt labels from Spain, England and France and describing the denotative and connotative meanings of each sign included in the graphics, disregarding brand elements and other information such as price and nutritional composition. These meanings were consistent with the general meanings found in the literature (Aicher, 1988; Dano, 1996; Chandler, 2002; Moskowitz *et al.,* 2005; Spang, 2010). As examples, horizontal straight lines suggest calm, tranquility, security and stability, whereas curved lines suggest smoothness, elegance, happiness, fantasy and youth. According to Vidales Giovannetti (1995) curved lines are also associated with femininity. As an example of meanings of colours, blue refers to calm, relaxation, safety, freshness, cleanness, peace.

2.2. Stimuli

As stimuli five distinct label concepts for plain yogurt were constructed based on signs that, according to the experts in semiotics, conveyed certain meanings to consumers. The main aim of the designs was that each one reflected the main messages that the experts previously identified in the real labels in the preliminary semiotic analysis. Plain yogurt was chosen to avoid direct associations with flavours. The designs of the

labels were kept as simple as possible to make the results easy to interpret and analyse, in addition, the only text included was: “yogur natural” (“plain yogurt”, in English) in different typographies depending on the main message of each label. The semiotics experts reviewed the concepts and confirmed that the messages created were equivalent to the ones identified in the real labels. Table 3.1 resumes their interpretation of the 5 designed labels, pointing out what each sign used represents. The images were presented in electronic format (72ppp; 7.5 x 8.5cm, similar in size to real yogurt labels), as shown in Figure 3.1.

Table 3.1. Summary of results from the semiotic analysis of the five yogurt labels concepts.

Label	Main message	Product characteristics, feelings and emotions to be conveyed by the label
Label 1	Natural, artisanal product	Freshness, naturalness, calm, relaxation, peace, purity
Label 2	Natural, ecological or organic product	Light or low-calorie, freshness, calm, relaxation.
Label 3	Premium, high quality product	Exclusiveness, authenticity, elegance
Label 4	Natural, positive effect on gastrointestinal health.	Dynamism, joy, naturalness, optimism
Label 5	High quality product, positive effect on weight control	Feminine, weight control, authenticity, dynamism, joy

Figure 3.1. Labels concepts used in the study. (1) label 1; (2) label 2; (3) label 3; (4) label 4; (5) label 5.

2.3. Participants

A representative number of participants (50) of each age group was intended. Age was divided into two ranges: younger than 35 years old, and over 60 years. Table 3.2 summarizes the number of participants according to their age, gender, and yogurt consumption frequency. Participants were randomly recruited at the Universitat Politècnica de València (UPV) and other public places, based on their interest in participating in the study. Older participants, and their carers or family in some cases,

were asked a few questions beforehand to ensure they would be able to fulfil the task successfully. They did not suffer dementia or depression. All participants were habitual consumers of yogurts.

Table 3.2. Demographic data of participants.

	Younger group (n=50)	Older group (n=51)
Mean age (years)	24.1	66.7
Gender distribution		
Men (%)	34	35.3
Women (%)	66	64.7
Yogurt consumption frequency distributions		
Every day (%)	25	22.9
Many times per week (%)	43	47.7
Less than once a week (%)	32	29,4

2.4. Procedure

Participants were asked to complete an electronic questionnaire with a word association (WA) task considering as stimuli the designed labels of a plain yogurt, which were presented individually in random order, following a complete block experimental design (William's Latin Square). Word association is a quick, simple and useful qualitative methodology commonly used in psychology and sociology (Ares *et al.,* 2010; Antmann *et al.,* 2011), and is based on the assumption that providing a stimulus to a respondent and asking him/her to freely associate what ideas come to his/her mind could give relatively unrestricted access to the respondent's mental representations of the presented stimulus.

Instructions given to participants were the following: "Please, write down all the words, images, associations, feelings, emotions and sensations that come to your mind when you see the following image of a plain yogurt label". An open-end blank space was provided were they could write as many words they required (max. 3000 characters). There was no time restriction, though all participants completed the task in 10-20 minutes.

2.5. Data Analysis

The elicited associations were qualitatively analysed. Terms with similar meaning (e.g. nature, countryside) were grouped in categories to avoid disregarding synonyms that were elicited with a lower frequency, which would bias the results (Guerrero *et al.,* 2010). This classification was performed by triangulation (Wadsworth, 2000; Modell, 2005) by three researchers with experience in semantic analyses considering word

synonymy as determined by a Spanish dictionary and personal interpretation. After individually evaluating the data, an agreement between their classifications was reached. Categories mentioned by more than 5% of the participants, for all the concepts, were considered. Frequencies of each category were determined by counting the number of terms that fell into that category to describe each label concept.

Friedman's test was conducted over each category term for both age groups individually to evaluate if each category was able to detect significant differences in the perception of the labels shown.

In addition, a Multiple Factor Analysis (MFA) was performed on the frequency table of the categories for each age group. Also, another MFA was conducted on the data of the two cohorts as separate data sets, to compare the positioning of the five samples as perceived by the two cohorts and to study the differences in their associative patterns.

Then, a more general categorization was carried out, grouping the previous categories into dimensions, i.e. sensory characteristics, emotions, etc. This task was carried out by triangulation by the same three researchers that performed the previous classification of terms. Frequencies of word counting in each broader group were calculated for each yogurt concept. Chi-square was calculated for evaluating differences in consumers' perception of the yogurt labels.

Statistical analyses were performed using XLStat 2009 (Addinsoft, NY, USA), except for the MFA, which was carried out using FactoMineR (Husson *et al.,* 2007; Lê *et al.,* 2008) in R language (R Development Core Team, 2007).

3. Results and Discussion

3.1. Elicited associations

At first, 65 categories were identified, but only those that were mentioned by more than 5% of the participants were considered. The resulting 54 categories for both groups are shown in Table 3.3. According to Guerrero *et al.,* (2000), the most frequently elicited concepts are the strongest and most important in consumers' minds. In this study, the most elicited associations for the younger group were *probiotics* (n=48), *diet* (n=42), and *natural* (n=41), whereas the most frequently elicited by the older participants were *nature* (n=48), *natural* (n=29), and *fresh* (n=29).

Table 3.3. Categories identified in the word association task and results of the Friedman's test.

Category	Younger	Older	Category	Younger	Older
Advertising	< .0001*	-	Modern	1.000	.007*
Artificial	.093	.106	Natural	.000*	.009*
Attractive	-	.255	Nature/ Countryside	< .0001*	< .0001*
Bland flavour	.283	.126	Not attractive	-	.092
Childhood	.349	-	Odd	.017*	.363
Classic	-	.219	Organic / Eco	1.000	.160
Brands	.010*	.181	Pleasant	-	.504
Cosmetics	< .0001*	-	Premium	1.000	.406
Cows	< .0001*	< .0001*	Probiotics	< .0001*	< .0001*
Creamy	< .0001*	< .0001*	Purity	.008*	.155
Diet/ Slimming	1.000	< .0001*	Peace	.627	.001*
Disliking	-	.240	Rejection to try/ purchase	-	-
Feminine	< .0001*	-	Runny/ Liquid	< .0001*	-
Flowers	< .0001*	< .0001*	Simple	.931	.343
Freedom	.004*	-	Skimmed	< .0001*	-
Fresh	.010*	< .0001*	Smooth	.015*	-
Fruits	-	-	Sober	-	-
Full fat	-	.199	Spring	-	.000*
Happiness	.034*	.001*	Sugar	.809	-
Healthy	.510	.085	Sweet	.675	-
Homemade	< .0001*	-	Tacky	-	-
Indifference	-	.066	Thick	1.000	-
Infusions	.000*	-	Traditional	< .0001*	.316
Light texture	.042*	.112	Vitality	-	.483
Liking	-	.049*	Willingness to try/ purchase	.227	.363
Maternal	-	.001*	Without additives	.001*	-
Milk	.003*	.000*	Yummy/ Tasty	.209	.493

Categories identified by – were mentioned by less than 5% of the participants for all the evaluated labels. *Indicates significant differences between the frequencies of the associations related to the model labels within each age group, for $p<.05$. A significant p-value means that the frequency of use of the term varied across labels.

These data reveal a first difference in perception between both age groups, as it is known that nowadays younger people pay more attention to the benefits that products may have for the body, perhaps because they are more persuadable by marketing. This is supported by the high frequency of mention of *brands* (n=35), especially of these types of products, by the youngsters compared to the elders (n=10). Figure 3.2 illustrates the frequencies (n) of the categories that were mentioned by at least 10% of the consumers from both groups for all the labels, where it can be seen great associative differences between the two groups.

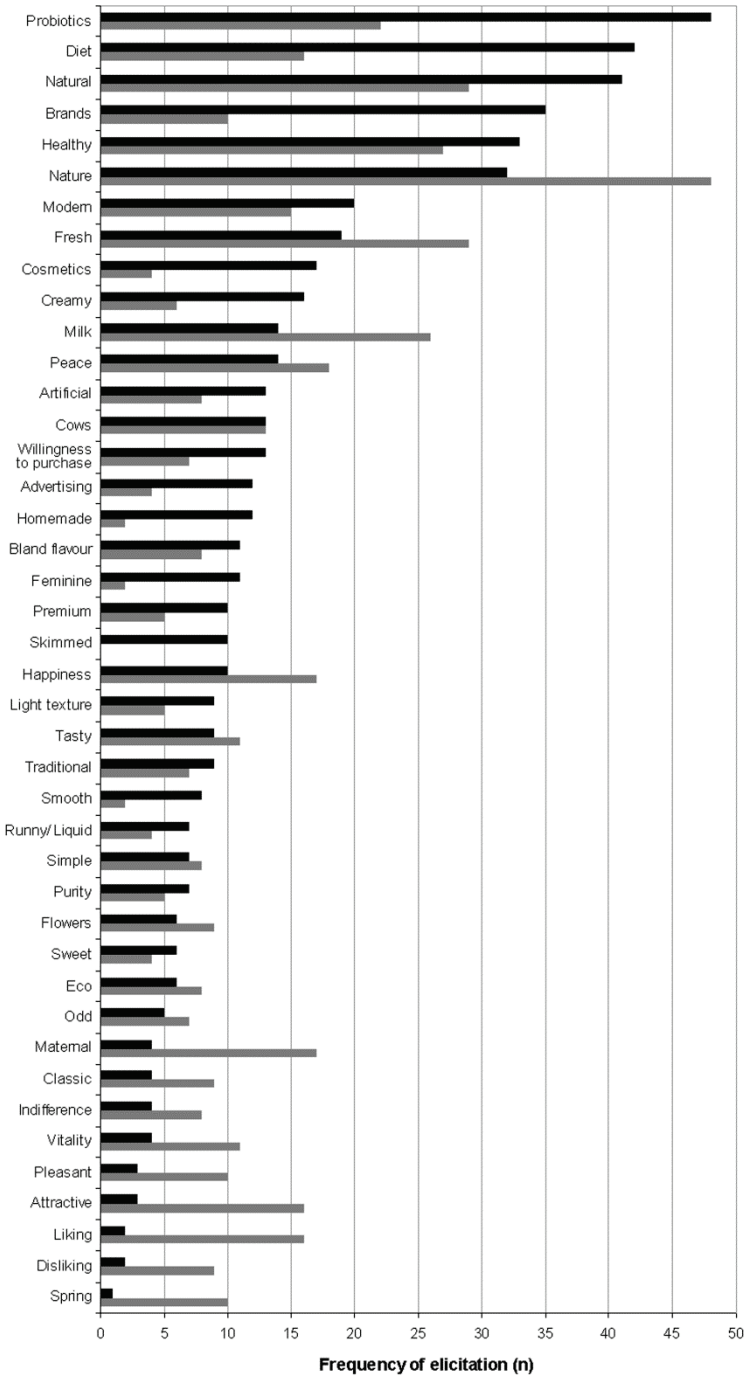

Figure 3.2. Frequencies of the categories that were mentioned by at least 10% of the consumers from both groups. (▪)the younger group's data; (▪) the older group's data.

Regarding the labels individually, Table 3.4 represents the 3 or 4 most elicited categories by each cohort for each label. As expected, the evaluated labels raised different associations in consumers' minds for both groups. These data already reflects important differences in the interpretation of the labels. The differences of use of terms such as probiotics, diet, skimmed, and feminine, which are not explicitly brand names or references to commercials, also suggest the impact that marketing has on the younger group, since nowadays many brands and commercials in Spain pursue this younger target group with those messages. In contrast, the older participants associated more hedonic and emotional meanings.

Table 3.4. Most elicited categories by each age group for each label in the WA task.

Label	Younger group		Older group	
	Category	n	Category	n
Label 1	Nature	20	Nature	27
	Natural	17	Cows	13
	Cows	13	Milk	11
	Homemade	12	Natural	11
	Tradition	9	Peace	10
Label 2	Nature	11	Nature	18
	Healthy	9	Fresh	14
	Natural	9	Natural	9
	Fresh	7	Flowers	9
	Flowers	6	Happiness	9
Label 3	Modern	17	Maternal	12
	Cosmetics	14	Milk	9
	Creamy	13	Modern	9
	Premium	7	Creamy	6
	Natural	7	Disliking	4
Label 4	Probiotics	44	Probiotics	20
	Brands	16	Healthy	9
	Advertising	11	Liking	4
	Diet	8	Fresh	4
	Healthy	6	Brands	4
Label 5	Diet	32	Diet	13
	Feminine	10	Attractive	7
	Skimmed	10	Classic	5
	Brands	9	Happiness	4
	Healthy	8	Healthy	4

3.2. Friedman's test

As shown in Table 3.3, according to Friedman's test, significant differences were found in the frequency of mention of 24 categories for the younger group and of 15 categories for the older, indicating that there were more adjectives that did not differ

among products in the case of the elderly in comparison to the number of terms used in the younger group. Therefore, youngsters used a higher number of terms to discriminate between the evaluated images than elders, in more categories. According to these results, younger consumers might associate the products with a wider range of values, and this association might be more affected by products' graphics than for older consumers. However, age influences functional brain activation during a cognitive task (Herrmann *et al.,* 2006), which might also explain the general differences in the number of terms used. In addition, younger consumers not only mentioned more frequently words related to marketing than older consumers, but they also used them to differentiate the labels significantly.

The great number of words that differed significantly for one group and not for the other, twenty-one, reflects the extent to which the perception and interpretation of the signs depended considerably on age. In the case of the elders, although design elements significantly affected their perception, they were less affected than youngsters.

3.3. Multiple Factor Analysis

Results from the MFAs performed on the WA frequency table for young and older consumers showed that the two age cohorts perceived and interpreted the signs of the labels considerably differently, though both cohorts identified the general messages conveyed by the labels.

In the MFA of the younger group (Figure 3.3), it can be seen at first sight, that they had clear groups of associations. The first three dimensions accounted for 87.1% of the variance of the experimental data, representing 35.9%, 26.7% and 24.4% of the variance respectively. The first dimension was positively correlated to terms related to nature, freshness, tastiness, full fat content, naturalness and tradition, and also to rejection to try/ purchase. All these terms were much related to Label 1, situated in the same area of the map (Figure 3.3b), indicating that the signs included in that label (blue sky, grass and wooden bucket) conveyed those messages. This picture indicates that they associated signs of freshness and nature to homemade and traditionally elaborated products, which are usually rich in fat content, and this might limit their willingness to buy these products, perhaps at a daily level.

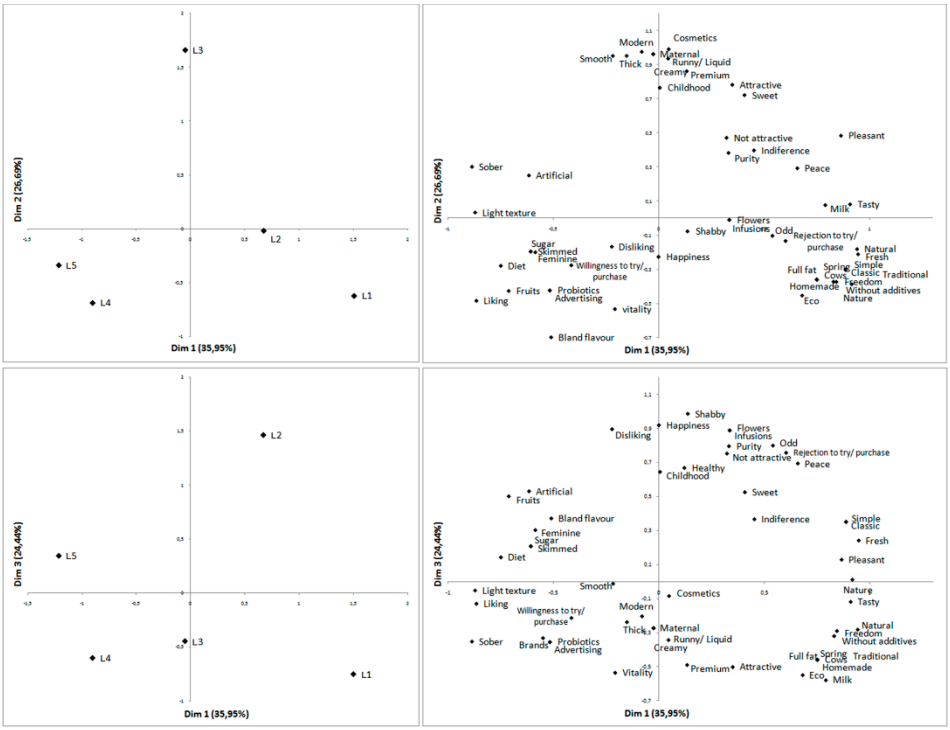

Figure 3.3. MFA representation of categories and labels for the younger group.

Label 2, which included mainly blue silhouettes of hills and daisies over a white background, was strictly related with flowers and infusions, but it was also regarded as odd, which might be reasoned by the fact that in Spain there are no real yogurt labels with similar graphics to that one.

Label 3, positively correlated to the second dimension, is the label that was more related to texture properties, due to the real image included. Interestingly, contradictory terms were related (i.e. *creamy, thick* and *liquid*), which is explained by the heterogeneity of the participants' texture perception. As the image showed just the content without packaging, it was also associated with other cosmetic products, like lotions, and with maternity, perhaps due to the fact that these other products also recur to this kind of graphic resource, and that it inspires softness. In addition, nearly all the terms related to the "status" of the product (i.e. *modern* or *premium*), were also located in the same area. It is known that dark colours are generally associated with luxurious and sophisticated products (Vidales Giovannetti, 1995; García Fernández,

2000; Acaso, 2009); however, this did not seem to influence much the hedonic appraisal.

Label 4 was strictly related to the probiotic category and to marketing (brands and advertising categories). Label 4 was mainly green and included an arrow pointing downwards as the main element. Since a commercial brand uses a similar symbol, and its advertisement is often shown on TV in Spain, participants referred to the meaning of intestinal help, to brands and to advertisements (which include the word *vitality*), without focusing much on other aspects. *Willingness to try/ purchase* and *liking* were also located near, which suggests that marketing might influence their purchase intention positively.

Label 5 was mainly related to diet, skimmed, fruits and women, which means that its signs (predominant lilac colour, the two yellow/orange curves, and the image of the yogurt pot with the full spoon) successfully conveyed those messages to them, having a positive hedonic appraisal.

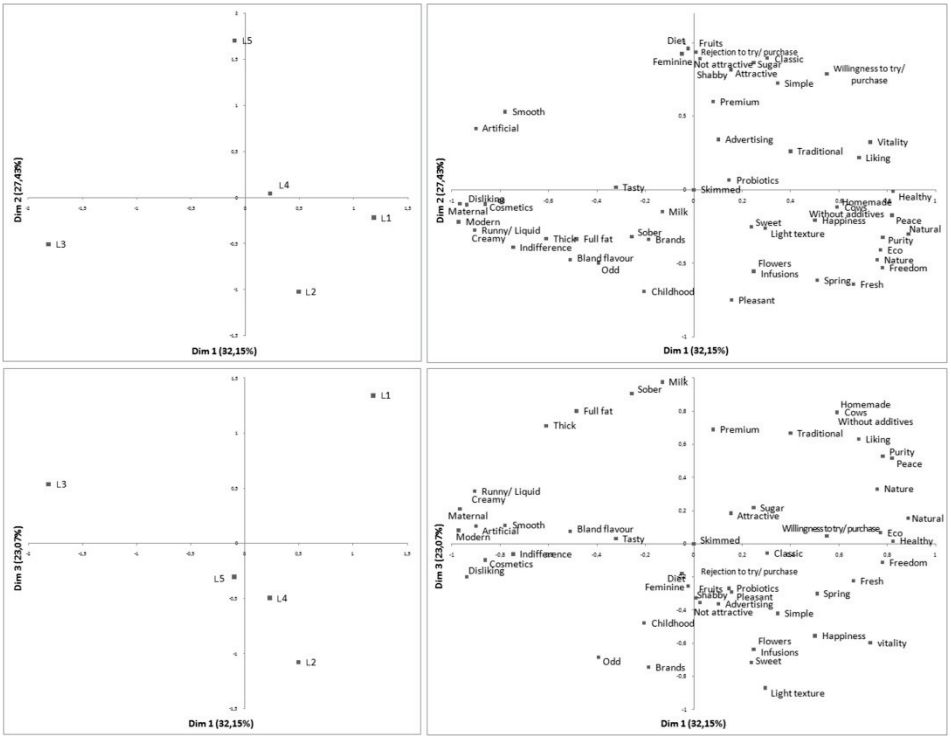

Figure 3.4. MFA representation of categories and labels for the older group.

On the other hand, as Figure 3.4 illustrates, older people's associations were not so clearly grouped. The first three dimensions accounted for 82.6% of the variance of the experimental data, representing 32.1%, 27.4% and 23.1% of the variance. Label 1, similarly to the younger group, was associated with nature, naturalness and homemade; however, they related these to liking and not to high fat content. In addition, in contrast to the younger group, the signs of Label 1 aroused more emotional states, like purity, freedom and peace. These emotional associations correspond to what semiotic studies have demonstrated about the colours of the label (mainly green and blue): freshness, naturalness and life for green colours and peace.

Label 2 was also related to flowers and infusions, but also to sweet and light texture. Label 3, located opposite to Label 1, was associated with cosmetic products, different texture properties and *modern*, similarly to the younger group. However, they seemed to dislike the association to cosmetic products or the modern appearance. Differently as well to the younger group, the dark colours did not convey luxury or elegance, as *premium* was not associated to this label.

Older participants strictly related Label 4 to *probiotics* and to *advertising*, and did not mention brands or express hedonic judgments, in contrast to the younger cohort. Finally, Label 5 was also related to diet, women and fruits; however, the hedonic reaction was quite different to the younger group, since they manifested rejection to try/buy and considered the label not attractive and tacky.

Comparing Figure 3.3 and Figure 3.4, it can be seen that the associations that most differed between the groups were related to the fat content, to the style of the label (e.g. *classic*, *attractive, sober* and *premium*), flavour (e.g. sweetness, blandness), marketing (*brands* and *advertising*), and as commented before, to hedonic associations. These differences indicate that the messages transmitted via the signs in the label were perceived in different ways. In addition, relating these data to the hedonic associations, it can also be noticed the values they might pursue by consuming yogurts with labels containing the evaluated signs.

Figure 3.5 illustrates the position of the label concepts in the first three dimensions of the MFA carried out on the data of the two cohorts as independent frequency data sets. These explained 82.8% of the variance of the experimental data, representing 31.6%, 28.2% and 23% of the variance. Data from young and older subjects contributed in a balanced way to the variance of the first three dimensions of the MFA, suggesting that the MFA representation takes into account data from both age groups.

It can be seen that the two age groups mostly differed in the general perception of Labels 3 and 4.

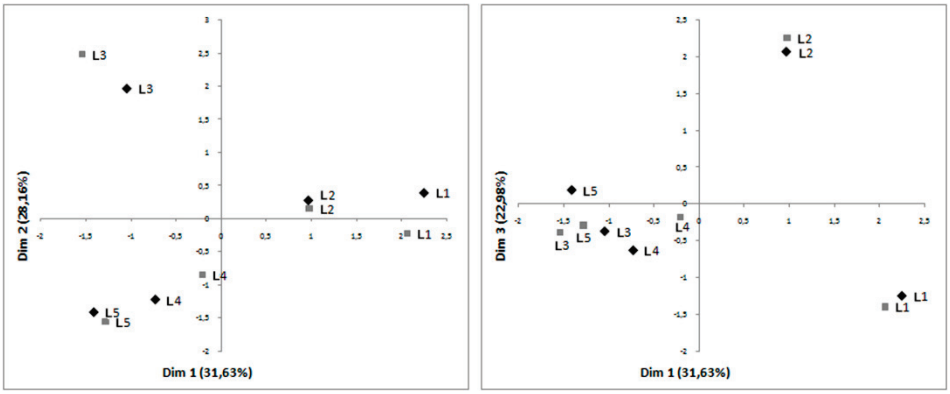

Figure 3.5. Representation of the labels in the multiple factor analysis performed on the data of the two age groups as independent frequency data tables. (◆) represents the younger group's data; (■) the olders' data.

The identification of the values that were associated with different products could enable an appropriate design of marketing and advertising campaigns for the specific target age group.

3.4. Generic dimensions

In order to perform a further reduction of the information facilitating the interpretation of the results obtained, the 54 categories created in the previous stage were grouped in different dimensions by triangulation (Wadsworth, 2000; Modell, 2005), obtaining a total of 9 dimensions by consensus. These dimensions were *Memory associations* (includes all terms that remind them of experiences/ things like flowers, cows), *Health* (includes terms like diet, healthy, probiotics), *Sensory* (includes all sensory attributes like creamy, sweet), *Style of product/label* (includes all the descriptors of the label like modern, simple), *Naturalness* (includes without additives, natural and artificial), *Emotions* (includes terms like happiness, freedom), *Hedonic liking* (includes positive appraisals of the product), *Hedonic disliking* (includes negative appraisals of the product), and *Fat content* (includes skimmed and full fat). Table 3.5 shows the frequencies of elicitation (%) of each dimension for each age group. The majority of the associations were related to memory for both cohorts. Interestingly, words related to health were more elicited by the younger cohort, indicating that the older one didn't perceive that meaning from the signs of the label. Also worth

mentioning is that young people used more associations that described the product itself (sensory, style of product, naturalness and fat content) based merely on the signs; whereas, in contrast, older participants used a higher number of terms related to emotions or acceptance. This suggests that they might not analyse so much the individual signs speculating about the attributes of the possible content. Instead, they seemed to get an overall impression and to express better in terms of saying how they feel and if they would try or buy the possible product.

Table 3.5. Frequencies of the elicited dimensions by each age group in the WA task.

Dimension	Frequency of elicitation by the younger group (%)	Frequency of elicitation by the older group (%)
Memory associations	25.7	28.1
Health	20.2	12.4
Sensory	15.1	12.7
Style of product	13.0	12.4
Naturalness	10.0	7.2
Emotions	6.7	10.3
Hedonic-liking	4.9	11.4
Hedonic-disliking	2.1	4.6
Fat content	2.1	1.0

4. Conclusions

Results demonstrated how different age groups interpreted signs and associated different meanings to them. In a study in which subjects were asked to give free associations to different label concepts, relevant pieces of information were extracted.

In general, both groups identified the main message that each label tried to convey. However relevant differences were found. Though the same association categories were found for both groups, their differences in frequency of mention revealed that some were more important or stronger for one group and not for the other. The younger group gave more relevance to the meanings related to diet, probiotics, and marketing, which were highly correlated. Therefore, it is not easy to tell whether the signs of the labels portrayed those meanings, or if it was the constant advertising they are exposed to what triggered those associations. Thus further research should be carried out to ascertain if some of the associations come purely from the knowledge and experience of commercial products. In any case, it evidenced the fact that marketing highly influenced and moulded their perception, due to the constant exposure to commercials. This seems to explain as well the use of a wider array of associations.

In the case of the older subjects, they did not interpret so much the properties of the product, which suggests that they do not rely so much on the cues of the individual signs but on the overall picture, and that they might need further explicit information about the product to fully understand it.

Considering the importance of an adequate interpretation of a product in a very short period of time, this study evidenced the necessity to concentrate on the *reading* (that develops into expectations) of the different age groups (Rowan, 2000; Deliza *et al.,* 2003). This is important to designers and market researchers because often, market research and trends only consider the younger cohort of consumers, missing opportunities to develop products and services for the only consumer sector with real growth potential.

Word association was an easy and useful method to uncover the relationships between the signs used and the meanings that aroused in the consumers' minds, which might influence their perception of yogurts and act upon their purchase intention. The ease of the technique is important when dealing with older subjects, as they tend to get fatigued easily, consequently affecting the performance of the task.

These results could help marketing teams to design more understandable and attractive labels that create appropriate expectations regarding the product. However, further research is necessary to investigate how the elicited associations affect consumer preference and purchase intention, and to check whether hedonic associations are in line with real preference scores.

Though conclusions are consistent, results observed in this study may depend on the selection of label profiles shown, which were inspired in the commercial labels.

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4 Crossmodal associations between colour and flavour. Expectations and oral perception

Crossmodal correspondences in product packaging: Assessing colour-flavour correspondences for potato chips (crisps)

Piqueras-Fiszman, B. & Spence, C. (2011). Crossmodal correspondences in product packaging: Assessing color-flavor correspondences for potato chips (crisps). *Appetite, 57,* 753-757.

Abstract

We report a study designed to investigate consumers' crossmodal associations between the colour of packaging and flavour varieties in crisps (potato chips). This product category was chosen because of the long-established but conflicting colour-flavour conventions that exist for the *salt and vinegar* and *cheese and onion* flavour varieties in the UK. The use of both implicit and explicit measures of this crossmodal association revealed that consumers responded more slowly, and made more errors, when they had to pair the colour and flavour that they implicitly thought of as being "incongruent" with the same response key. Furthermore, clustering consumers by the brand that they normally purchased revealed that the main reason why this pattern of results was observed could be their differing acquaintance with one brand versus another. In addition, when participants tried the two types of crisps from "congruently" and "incongruently" coloured packets, some were unable to guess the flavour correctly in the latter case. These strong crossmodal associations did not have a significant effect on participants' hedonic appraisal of the crisps, but did arouse confusion. These results are relevant in terms of R&D, since ascertaining the appropriate colour of the packaging across flavour varieties ought normally to help achieve immediate product recognition and consumer satisfaction.

Keywords: Crossmodal correspondences; packaging colour; flavour perception; Implicit Association Test (IAT); congruency; consumer behaviour; expectation

1. Introduction

Colours have a powerful effect on us (e.g., Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Spence, 2010). In fact, colour is one of the most potent features in the design of product packaging in the food industry (e.g., Deliza, MacFie, & Hedderley, 2003; Hine, 1995; Hutchings, 2003). According to Hine, consumers perceive packaging colour at three different, and, in practice, interrelated levels: the physiological, the cultural, and the associational. The associational level refers to those packaging colour expectations that have become associated with a brand image or even a product category, through consumers having interacted with it over some extended period of time (see Cheskin & Ward, 1948; Garber, Hyatt, & Boya, 2008; Spence, 2011).

Consumers can often draw important clues as to a product's likely qualities on the basis of nothing more than the colour of the packaging. Colour can therefore be considered as an important source of sensory and hedonic expectations, especially for those products that are consumed directly from the packaging (Day, 1985). A mismatch between the expected and actual attributes of the product can all-too-easily result in a negative "disconfirmation of expectation" (Cardello & Sawyer, 1992; Schifferstein, 2001). If this occurs, consumers may well not buy the product again (Deliza & MacFie, 1996).

Numerous studies have been published over the years documenting the role that packaging colour plays in driving consumer expectations (e.g., Ares & Deliza, 2010; Cheskin, 1957; Deliza *et al.*, 2003; Marshall, Stuart, & Bell, 2006; Piqueras-Fiszman, Ares, & Varela, 2011). The reality is that people are affected by packaging, specifically by its colour, in ways that they do not necessarily understand at a conscious level (see Cheskin, 1957). Researchers have demonstrated that shoppers often do not read the information that is presented on packages (Charters, Lockshin, & Unwin, 1999); they mainly recognize what they want or need in order to make a quick purchasing decision. Since colour is perhaps the one feature of the packaging that triggers the fastest response (Swientek, 2001), it is essential to consider in the design process the associations and expectations that consumers have in order to ensure effectiveness and the successful communication of brand/sensory qualities (cf. Louw & Kimber, 2011).

On the other hand, such a strong impact on the minds of consumers can have negative side-effects too. In fact, even fairly subtle modifications to the colour of the packaging can have dramatic emotional consequences. Hence, when a company decides to

change the style of a product's packaging, or to introduce a new item to a product line, designers should collect insights about how consumers' expect the product to be represented. In many cases, there are already well-established conventions about what colours are more appropriate to certain product categories, and in certain cultures/geographical regions (e.g., Sacharow, 1970; Spence, 2010; Wheatley, 1973).

A clear example of this idea is provided by crisps (or potato chips). Here, each flavour variety is typically represented by an arbitrary colour. The established convention (or crossmodal correspondence; Spence, 2011) linking the colour to the flavour can help to facilitate a shopper's ability to rapidly and effortlessly identify the particular flavour that they want. For example, in the UK, salted crisps predominantly come in red packaging across many different brands, whereas *salt and vinegar* flavoured crisps are typically presented in blue packets instead. According to the extant literature, a change in this colour code would be expected to provoke disconfirmation of expectation and confusion in the minds of consumers.

Contrary to this expectation, however, in the early 1980's, Walkers switched the colour of their *cheese and onion* (green) and *salt and vinegar* (light blue) flavoured crisps packages to blue and green, respectively. The consequent confusion that arose in the minds of consumers actually led to an increase in sales of their recently-introduced *salt and vinegar* crisps (h2g2, BBC, 2006). This 'new' colour combination has been maintained ever since, and by so doing, challenges the association that is present for the majority of crisps brands found nowadays in UK supermarkets. Contemporary consumer forums are rife with disgruntled shoppers who report arriving home and opening what they thought was their favourite flavour crisps package only to find that they had actually bought the wrong crisps.

Such reports highlight the tendency for consumers to blindly rely on packaging colour, and what information they believe it conveys about the product. Relevant here is Garber *et al.*'s (2008) observation that the enhanced attentional capture that can result from introducing novel packaging colours will not necessarily translate into increased purchase intention unless the new colour happens to evoke a meaning that is consistent with favourable product performance for that particular category. It can be argued that the case of Walkers remains one of the few successful relaunches of incongruent colour packaging that has made its way in the marketplace, probably due to the fact that the colour matching for crisp flavours was relatively novel at the time

and also essentially arbitrary. Why, after all, should red have been associated with *ready salted* and blue with *salt and vinegar* in the first place?

The adverse consumer reactions that were reported earlier highlight the need for sensory R&D teams to try and find congruent combinations of sensory variables that are easily interpreted and, what is more, acceptable to consumers. However, this goal is not as easy to achieve as it might seem since consumers often find it difficult to articulate certain associations, principally due to their sometimes unconscious nature.

In this context, the use of the implicit association task (IAT) can be very useful. As opposed to self-report measures, in which participants are asked to express their attitude in a conscious deliberate way, implicit measures that are obtained indirectly are considered to be more sensitive to automatic stimulus evaluations (De Houwer, 2003, 2009; De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). In the IAT, 'compatible' associations typically give rise to faster (and more accurate) responses than 'incompatible' ones. Thus, measuring implicit and explicit associations of the colour of food packages, in addition to explicit ratings of pleasantness, may be expected to provide more detailed information, and may present a better reflection of consumers' spontaneous evaluations (e.g., as they occur in the supermarket setting).

The aims of the present study were therefore: 1) To investigate consumers' implicit flavour associations toward the colour of crisp packages, namely the *salt and vinegar* and *cheese and onion* flavour varieties, using a variant of the IAT; 2) To test the crossmodal associations across a wide age range of participants in order to determine whether the associations that people hold have changed over time; and 3) To study whether the colour of the packaging affects flavour identification and liking.

2. Materials and methods

2.1. Participants

Twenty five participants (16 female) ranging from 18 to 63 years of age (M=33.6 years: SD=13.3) took part in the study. All reported normal or corrected-to-normal vision. The experimental procedure was approved by the Ethics Committee of the Department of Experimental Psychology, University of Oxford. The experiment lasted for 20 minutes.

2.2. Apparatus and materials

For the IAT variant, a computer running E-Prime 2.0 (Psychology Software Tools, Inc.) was used. Participants were seated 50 cm from a 17" CRT monitor with a resolution of 1280*960 pixels (refresh rate 60 Hz). The experiment was conducted in a quiet room

under normal illumination conditions. Four visual stimuli were presented: two coloured pictures and two word attributes. The two pictures showed two crisps packets: one blue and the other green (15 cm high by 10 cm wide), identical except for their colour (see Figure 4.1). In both images, the flavour label was removed using Adobe Photoshop CS 8.0 (Adobe Systems Incorporated, 2003). The word stimuli consisted of the flavours "cheese & onion" and "salt & vinegar" presented in black, uppercase Arial 24 pt font, all presented against a white background.

Figure 4.1. Images of the crisp packets presented during the IAT version.

2.3. Procedure

2.3.1. IAT variant. Participants were instructed to maintain their fixation on the centre of the screen and to respond to the target stimuli as rapidly and accurately as possible. At the beginning of each block of trials, written instructions were presented on the screen informing the participants of the mapping for the upcoming block. In each block of trials, two of the stimuli, one figure and one word, were assigned to either the left or right response key, while the remaining two stimuli were assigned to the other response key. Participants responded by pressing one of two keys on a computer keyboard.

Each trial began with the presentation of a stimulus, either a word or a picture, from the centre of the screen. The visual stimulus was displayed for 2,000 ms, or until a response had been recorded. At the end of each trial, feedback was given regarding the correctness of the participant's response (either the word "correct" or "incorrect").

If no response was made within 2,000 ms of target onset, the trial was terminated and the feedback "no response detected" was presented.

The mapping of the stimuli onto the response keys was manipulated during the experiment, thus generating four different blocks of trials. Each of the four stimulus-response blocks was repeated three times giving rise to a total of 12 randomly ordered blocks of experimental trials, presented with a randomized order within each participant's experimental session. Each block consisted of 20 trials (with each stimulus being repeated five times) giving rise to a total of 240 trials completed by each participant (Table 4.1). At the start of the experiment, two practice blocks (40 trials) were performed in order to familiarize participants with the procedure. The reaction time (RT) and accuracy of participants' responses were collected.

Table 4.1. Summary of the blocks of the IAT variant.

Block	Procedure	Left response key	Right response key	Number of repetitions	Total number of trials
1	Combination 1	Blue packet "Cheese & onion"	Green packet "Salt & vinegar"	5 5	20
2	Reversed combination 1	Green packet "Salt & vinegar"	Blue packet "Cheese & onion"	5 5	20
3	Combination 2	Blue packet "Salt & vinegar"	Green packet "Cheese & onion"	5 5	20
4	Reversed combination 2	Green packet "Cheese & onion"	Blue packet "Salt & vinegar"	5 5	20

2.3.2. Explicit evaluations. After completing the variant of the IAT task, the same participants were given four crisps packets: two of *cheese and onion*, and two of *salt and vinegar* (Walkers, UK), one at a time. In two cases, the crisps were served from their original packaging, while in the others, the contents were switched. The order of presentation of the crisps packets was counterbalanced across participants, natural mineral water and water crackers were available for rinsing between samples. Participants had to write down the flavour of the crisp they had just eaten, rate how much they liked it using a 9-point hedonic scale (1 being 'extremely dislike' and 9 'extremely like'), and indicate what colour they thought that a packet for that flavour of crisp should be. They were also asked which brand of crisps they normally consumed. Finally, they were debriefed.

2.4. Data analyses

Response times below 250 ms or above 2,000 ms (1.2% of responses) were considered as outliers and hence excluded from further analysis (Veldhuizen, Oosterhoff, & Kroeze, 2010). Repetitions of the same block did not give rise to significantly different RTs, so blocks of the same type (1 and 2; and 3 and 4; cf. Table 4.1) were averaged (these are henceforth referred to Combinations 1 and 2, respectively).

In order to measure the IAT effect, the *D*-measure was calculated from participants' RTs as suggested by Greenwald, Nosek, and Banaji (2003). This measure is similar to the effect-size measure *d* (Cohen, 1977). In addition, analyses of variance (ANOVA) were performed on the RTs and on the hedonic data, a *t*-test was carried out on the error rates (%) to compare the accuracy between the two combinations, and finally, a Kruskall-Wallis test was performed over the colour-flavour matching frequency data. Effects were considered significant when $p \leq .05$. Statistical analyses were performed using XLStat 2011 (Addinsoft, NY, USA).

3. Results and discussion

A summary of the effects of the IAT variant are illustrated in Table 4.2. The *D*-measures without the errors were considered since values calculated including and excluding the error response latencies did not differ significantly (p=0.83). Positive and negative values signify an incongruent and congruent association with Combination 1, respectively. The larger the positive value, or the lower the negative value, the stronger the association with Combination 2 or 1, respectively. As shown in Table 2, the mean *D*-measure of participants who reported a clear preference for a brand of crisps other than Walkers (Cluster O) scored a positive *D*-measure. In contrast, the mean score of the participants who reported Walkers as their usual brand (Cluster W) was negative.

Table 4.2. IAT effects.

Brand cluster	Mean latencies in ms (SD)		D-measure	Error rates in % (SD)	
	Comb. 1	*Comb. 2*		*Comb. 1*	*Comb. 2*
Walkers	553 (215) [c]	620 (224) [a]	-0.36	3.0 (1.8)	5.6 (2.9)
No specific	648 (210) [a]	622 (191) [bc]	0.09	4.3 (2.5)	4.5 (2.6)
Other brand	599 (204) [bc]	507 (157) [d]	0.49	5.0 (1.2)	2.7 (1.6)
Total	**602 (210)**	**584 (200)**	**0.07**	**4.1 (2.0)**	**4.3 (2.6)**

Values with different superscripts in the mean latencies are significantly different (p<.05) according to Tukey's test.

According to the results of the ANOVA, the preferred brand of crisp had a significant effect ($p<.0001$) on the associative patterns exhibited by participants. A significant interaction between the preferred brand and the type of combination was also observed ($p<.0001$). Tukey's test revealed significant differences ($p<.001$) between the mean RTs of Clusters W and O for each combination (Table 4.2). Those in Cluster O found it particularly difficult to link what in their heads was an "incongruent" combination (Combination 1). Meanwhile, for this combination, the mean RTs of participants who had no preference for a specific brand (Cluster N) were only significantly different ($p<.05$) from those of Cluster W.

By contrast, for Combination 2, Cluster N's RTs were significantly different from those of Cluster W ($p<.05$) and Cluster O ($p<.0001$). This result suggests that the fact that the consumers in this cluster were not especially well-acquainted with any particular brand resulted in their having no clear association between specific flavours and colours, hence they reacted differently when pairing one combination of stimuli or the other to a specific response key during the task.

The total error rates were calculated for each combination and for each brand cluster of consumers (Table 4.2). The accuracy of Clusters W and O differed significantly ($p<.05$) from one combination to the other. The accuracy of Cluster N's performance did not vary significantly as a function of the combination. When analyzing the data within combinations, significant differences were also observed in the error rates between Clusters O and W ($p<.05$).

Regarding the explicit measures, the top part of Table 4.3 shows the number of times that participants suggested a colour which matched one or the other combination, while the bottom part shows the number of times that they guessed the correct flavour, as per each combination. Significant differences ($p<.001$) were observed between the colour-flavour matches among the brand clusters. Most Cluster W participants suggested a colour-flavour code according to Combination 1 when they tasted the four crisps, even when the contents of the packets were switched (as in Combination 2).

Table 4.3. Results of the tasting and colour-matching task by brand cluster.

Total number of colour-flavour matches		
Brand cluster	***Combination 1***	***Combination 2***
Walkers	13^{c}	1^{ab}
No specific	9^{bc}	5^{ab}
Other brand	0^{a}	14^{c}
Total number of correct flavour responses		
Walkers	15	13
No specific	16	14
Other brand	16	12
Total	**47**	**39**

Values with different superscripts are significantly different according to Dunn's test (Bonferroni's corrected level of significance at $p<0.033$).

The opposite was true for most Cluster O participants. Meanwhile, Cluster N participants did not express a clear pattern of crossmodal association (or correspondence). In fact, they were the participants who had the greatest difficulty in terms of guessing the flavour of the crisps and suggesting a colour for the packaging.

Regarding the flavour guessing task (bottom part of Table 4.3), when the crisps were presented as in Combination 2, more participants reported tasting incorrect flavours than when tasting the crisps from the original packets (Combination 1). In general, the participants appeared somewhat confused and surprised when the flavour did not match their visually-induced expectations.

The repeated-measures ANOVA performed on the hedonic data revealed no significant differences between the original and switched condition. However, it is worth noting that in those conditions where the participants guessed the flavour correctly; liking scores were higher for all clusters (5.7 vs. 6.5 in total). Presumably more distinctly-different crisp flavours could have had a stronger impact on the acceptance of the crisps in the incongruent condition.

4. General discussion

The present study was designed to investigate the extent to which consumers associated specific flavours to specific packaging colours in a product category where colour is used to identify product varietals. If these associations existed implicitly in the mind of consumers (whichever brand they normally consumed), shorter RTs should have been observed where they had to pair the colour and flavour according to what they perceived to be a "congruent" combination. Consistent with the literature, the results of this study demonstrate that "incongruent" pairings for each brand cluster of

consumers not only gave rise to longer RTs, but also to more incorrect responses. This result indicates that participants found it more difficult in those trials because, for them, the matching of stimuli to the response keys was incongruent. In this sense, the version of the IAT proved to be a reliable behavioural tool with which to explore consumers' underlying correspondences regarding the colour of the packaging. Moreover, the results were consistent with the explicit evaluations on the perceived flavours and suggested colours for the packaging, thus demonstrating that the two parts of the experiment complemented each other and that the methodology proposed is robust.

The results of the present study therefore provide evidence concerning the influence of brand acquaintance on the associations that have developed over time between the attributes (in this case, the colour) of a package and what it/they convey about the contents (in this case, flavour) of the packaging in consumers' minds. It is worth highlighting the fact that the colour of the packets exerted a stronger influence on participants' association than the brand name, since in the images shown the brand was visible. This is relevant since a product category such as crisps is, in many cases, bought impulsively. Hence the colour used in packaging can be equally important in determining a product's desirability.

Further research will be needed in order to determine why it is that consumers relate specific colours with particular flavours. Based on the results of this study, familiarity with the product is likely to be a key factor (De Houwer *et al.*, 2009). It is, however, important to note that there are also other possible interpretations for the results reported here in terms of salience asymmetries (Rothermund & Wentura, 2004). In this context, salience can be defined in terms of the degree to which a stimulus (or pair of stimuli) are familiar to the participant, and/or the degree to which a stimulus pops out within a background of other stimuli. If, for instance, a consumer is only familiar with *cheese and onion* crisps in blue packets, whenever he/she has to pair that combination with the same response key, the task is facilitated, no matter what the incongruent pairing is (because of the pairing of salient stimuli with the response key). Presumably, according to the salience account, participants should be able to pair any combination of salient (or familiar) features/products to the same response key, whether or not they happen to refer to the same object.

What, then, should a company do when considering the launch of a new product (or the relaunch of an existing product)? By getting the colour 'right', companies should

hopefully be able to deliver products that are immediately recognized (enhancing perceptual fluency; Labroo, Dhar, & Schwartz, 2008) that match the expectations of the consumers (those loyal and those undecided) and increase not only their satisfaction, but also their sales.

Though much research has been already carried out on the general meaning of colour for consumers (e.g., Madden, Hewett, & Roth, 2000; Schmitt & Pan, 1994; Wheatley, 1973) further research will be needed in order to empirically relate packaging colours , their meaning and associations, and these perceptual constructs, specifically within product categories, not to mention across cultures (Spence, 2010).

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5 Crossmodal correspondences: Are they learned? Do they vary across cultures?

Exploring implicit and explicit crossmodal colour-flavour correspondences in product packaging

Piqueras-Fiszman, B., Velasco, C, & Spence, C. (2012). Exploring implicit and explicit crossmodal colour-flavour correspondences in product packaging. *Food Quality and Preference, 25,* 148-155.

Abstract

We report a study designed to investigate consumers' crossmodal associations between the colour of product packaging and flavour varieties in crisps (potato chips) among Colombian and British consumers, using two methods. In a modified version of the Implicit Association Test (IAT), the stimuli consisted of green and blue coloured packets and the flavours normally paired with these colours for a certain brand in the UK and Colombia. In an explicit word (colour) association task, unbranded, grayscale packets with three new flavours were shown instead. The results obtained from both tasks revealed two main different kinds of associations between the colour of the packaging and flavour types: 1) A learned association through a conventional pairing attributable to a specific brand, and 2) an association between a flavour and its potential packaging colour, based on the colour of the primary ingredients. In addition, when comparing associative patterns documented in the two countries, no specific cultural differences were found. The techniques used here and the results reported are relevant for R&D since they contribute to the existing knowledge on colour associations and raise questions regarding their origin.

Keywords: Crossmodal correspondences; packaging colour; flavour; Implicit Association Test (IAT); congruency; word association

1. Introduction

Consumers often draw important clues as to a product's likely qualities on the basis of nothing more than the colour of the package/label in order to make a quick purchase decision. In fact, it has been argued that colour drives 60-90% of the consumer's purchase decisions (see Singh, 2006). Packaging colour can therefore be considered as an important source of sensory and hedonic expectations, especially for those products that are consumed directly from the packaging (e.g., as is often the case for crisps). If a mismatch between the expected and actual attributes of the product occurs, consumers may well not buy the product again (Deliza & MacFie, 2001; Yeomans, Chambers, Blumenthal, & Blake, 2008). Over the years, numerous studies have documented the role that the colour of product packaging plays in driving consumer expectations (e.g., Ares & Deliza, 2010; Marshall, Stuart, & Bell, 2006).

Colour (and colour schemes) in food packaging is, for example, used to identify product attributes, such as flavours, likely price, and even target consumer groups (Kauppinen-Räisänen & Luomala, 2010). However, complications can arise when the meaning associated with a particular packaging colour or combination of colours also differs between cultures. Hence getting the colour of the packaging right can be crucial.

In addition, it is important to realize that even fairly subtle modifications to the colour of the packaging can have dramatic emotional consequences. Hence, when a company decides to introduce one of their successful products into a foreign market, R&D teams should consider carrying researching how the colour scheme present in the packaging and their associations in order to evaluate how different packaging colour drives consumer expectations, as well in different cultures.

Companies have to consider the specific sensations (and semantic concepts) that they want to transmit, and to seek to find a congruent combination of sensory variables that is both easily interpreted and acceptable to consumers. However, consumers often find it difficult to articulate certain associations, principally due to their sometimes unconscious and implicit nature, which can change between contexts and can be culturally-determined (Karpinski & Hilton, 2011). Therefore, the use of implicit association tasks (IAT) might be expected to be very useful (De Houwer, 2003, 2009). Measuring the implicit associations that consumers in different markets have with the colours present in food packages may provide a better means of assessing and

predicting the spontaneous evaluations of consumers' (e.g., as may occur in the supermarket setting).

Recently, Piqueras-Fiszman and Spence (2011) investigated consumers' crossmodal associations (Spence, 2011) between the colour of packaging and flavour varieties in crisps (potato chips) among different brand consumer clusters in the UK using a variant of the IAT. This product category was chosen because of the long-established colour-flavour conventions that exist for the *salt and vinegar* and *cheese and onion* flavour varieties in the UK across brands. The results revealed that consumers responded more slowly, and made more errors, when they had to pair the colour and flavour that they implicitly thought of as being "incongruent" with the same response key. It was suggested that the main reason why this finding was observed could be the participants' differing acquaintance with one brand versus another (and the associated mappings between colour and flavour).

The main aims of the present study were therefore: (1) To investigate consumers' implicit flavour associations toward the colour of branded crisp packages, by switching the colour-flavour code, and also including unfamiliar colour-flavour combinations; (2) To asses explicit colour-flavour associations with uncoloured packages of a fictitious brand and unfamiliar flavour labels in order to avoid any possible influence of brand acquaintance on the results; And, lastly (3) To check for any cultural differences comparing results from two countries, namely Colombia and UK.

2. Materials and methods

2.1 IAT variant

2.1.1 Participants. Twenty-four Colombian participants (11 female) aged between 18 and 45 years (M= 26.1 years; SD= 6.6), and 24 British participants (15 female) aged between 19 and 43 years (M= 27.6; SD= 6.3) took part in the experiment. They were all regular consumers of Frito Lay's Margarita and Walkers, respectively. All of the participants reported normal or corrected-to-normal vision. The experimental procedure was approved by the Ethics Committee of the Department of Experimental Psychology, University of Oxford. The participants volunteered for the experiment which lasted for approximately 20 minutes.

2.1.2 Apparatus and materials. The presentation of stimuli, and the collection of responses for the IAT, was controlled by a personal computer running E-Prime 2.0 (Psychology Software Tools, Inc.). Each participant was seated approximately 50 cm in front of a 17" CRT monitor with a resolution of 1280*960 pixels (refresh rate 60 Hz). In

both countries, the experiment was conducted in a quiet room under normal illumination conditions. Six different visual stimuli were presented: two coloured pictures and four word attributes. The two pictures showed crisp packets: one blue and the other green, identical for each country except for their colour (see Figure 5.1 for the images shown in the two countries). In both images, the flavour label was removed using Adobe Photoshop CS 8.0 (Adobe Systems Incorporated, 2003). The pictures were approximately 15 cm high by 10 cm wide, and were presented on the screen against a white background. The word stimuli consisted of the flavours "queso y cebolla" [cheese and onion], "sal y vinagre" [salt and vinegar], "natural" [plain], and "limón" [lemon] presented in black, uppercase Arial 24 pt font against a white background. The English terms were used in the experiment carried out in the UK.

Figure 5.1. The crisp packet images presented during the IAT experiment; a) to the Colombian participants; and b) to the UK participants.

2.1.3 Procedure. The procedure followed was that used by Piqueras-Fiszman and Spence (2011), an adaptation of the IAT (Greenwald, McGhee, & Schwartz, 1998). At the beginning of each block of trials, written instructions were presented on the screen

informing the participants of the mapping between the stimuli and the appropriate response for the upcoming block of experimental trials. In each block of trials, two of the six stimuli, one figure and one word, were assigned to either the left or right response key, while the remaining stimuli were assigned to the other response key. The instructions remained visible on the screen until the participant initiated the block of trials by pressing the enter button. The mapping of the stimuli onto the response keys was manipulated during the course of the experiment, thus generating four different blocks of trials for each country, two congruent and two incongruent (see Figures 4.2 and 4.3, for examples of the mappings for the Colombian and UK participants, respectively).

Figure 5.2. The instructions screen shown to the Colombian participants. a) Example of a congruent block; and b) example of an incongruent block.

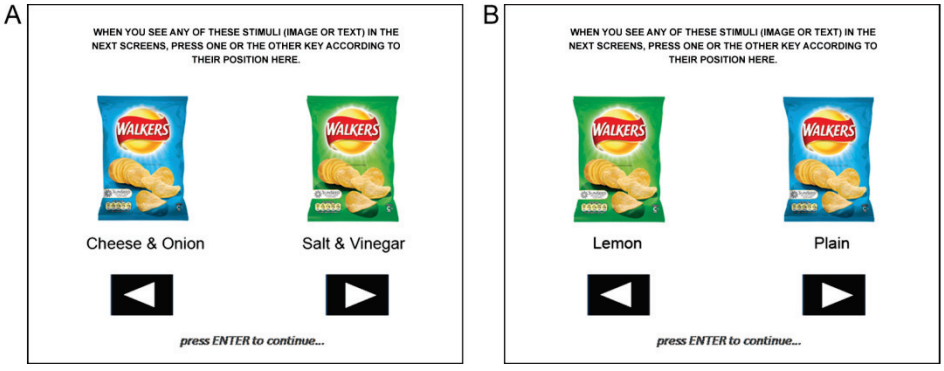

Figure 5.3. The instructions screen shown to the UK participants. a) Example of a congruent block; and b) example of an incongruent block.

The participants were instructed to maintain their fixation on the centre of the screen and to respond to the target stimuli as accurately and as rapidly as possible. The participants responded by pressing one of two response keys on a computer keyboard. The relevant keys were marked by two patches representing an arrow pointing to either the left or right. Each trial began with the presentation of a stimulus, either a word or a picture, from the centre of the screen. The visual stimulus was displayed for 2,000 ms, or until a response had been recorded. At the end of each trial, feedback was provided regarding the correctness of the participant's response (the word "correct" in blue or the word "incorrect" in red). If no response was made within 2,000 ms of target onset, the trial was terminated and the feedback "no response detected" was presented in red at the centre of the screen.

In the experiment carried out in Colombia, the congruent combination was blue with *plain* and green with *lemon*, and the incongruent was blue with *cheese and onion* and green with *salt and vinegar* (see Table 5.1 and Figure 5.2).

Table 5.1. Summary of the IAT blocks presented to the Colombian participants.

Block	Procedure	Left key	Right key	Number of repetitions	Total number of trials
1	Combination 1	Blue packet "Cheese & onion"	Green packet "Salt & vinegar"	5 5	20
2	Reversed combination 1	Green packet "Salt & vinegar"	Blue packet "Cheese & onion"	5 5	20
3	Combination 2	Blue packet "Plain"	Green packet "Lemon"	5 5	20
4	Reversed combination 2	Green packet "Lemon"	Blue packet "Plain"	5 5	20

In the experiment carried out in the UK, the combinations were created in two ways: a) Once by switching the colour and flavour of the packets as shown in Table 5.2a and Figure 5.3; and b) in another separate experiment, having as the incongruent combination the flavour-colour pairing used in Colombia (see Table 5.2b).[1]

[1] The British participants who took part in task (b) consisted of 16 of the 24 previously-described participants (11 female; M= 25; SD= 4.1).

Table 5.2a. Summary of the IAT blocks (2-word stimuli) presented to the UK participants.

Block	Procedure	Left key	Right key	Number of repetitions	Total number of trials
1	Combination 1	Blue packet "Cheese & onion"	Green packet "Salt & vinegar"	5 5	20
2	Reversed combination 1	Green packet "Salt & vinegar"	Blue packet "Cheese & onion"	5 5	20
3	Combination 2	Blue packet "Salt & vinegar"	Green packet "Cheese & onion"	5 5	20
4	Reversed combination 2	Green packet "Cheese & onion"	Blue packet "Salt & vinegar"	5 5	20

Table 5.2b. Summary of the IAT blocks (4-word stimuli) presented to the UK participants.

Block	Procedure	Left key	Right key	Number of repetitions	Total number of trials
1	Combination 1	Blue packet "Cheese & onion"	Green packet "Salt & vinegar"	5 5	20
2	Reversed combination 1	Green packet "Salt & vinegar"	Blue packet "Cheese & onion"	5 5	20
3	Combination 2	Blue packet "Salt & vinegar"	Green packet "Lemon"	5 5	20
4	Reversed combination 2	Green packet "Cheese & onion"	Blue packet "Plain"	5 5	20

These combinations were chosen to check for salience asymmetries (Rothermund & Wentura, 2004); That is, participants' performance might be facilitated when the pairing is congruent, no matter what the incongruent combination happens to be. In this case, the incongruent pairing could be the flavour-colour combination used in another country, or a switch in the same flavour-colour combination. In addition to testing two types of hypothesised-incongruent combinations, this experimental design allowed us to investigate which of the stimulus combinations was more incongruent. The design also allowed us to check whether having two word-stimuli would result in smaller differences between the reaction times (RT) of different blocks than having four word-stimuli.

Each of the four stimulus-response blocks was repeated three times giving rise to a total of 12 randomly ordered blocks of experimental trials, presented in a randomized order within each participant's experimental session. Each block consisted of 20 trials (with each stimulus being repeated five times) giving rise to a total of 240 trials completed by each participant (see Tables 4.1 and 4.2). At the start of the experiment,

a practice block (20 trials) was performed in order to familiarize the participants with the procedure. The RT and accuracy of participants' responses were collected. After collecting the data for both tasks, the participants were fully debriefed as to the nature and purpose of the study.

2.1.4 Data analyses. RTs shorter than 250 ms or longer than 2,000 ms (2% of all responses) were considered as outliers and hence excluded from further analysis (Lamote, Hermans, Baeyens, & Eelen, 2004). Repetitions of the same block did not give rise to significant differences in RT, and so blocks of the same type (1 and 2; and 3 and 4; cf. Table 5.1) were averaged (henceforth Combinations 1 and 2, respectively). Additionally, error rates were calculated for each combination.

In order to measure the IAT effect, the *D*-measure was calculated from participants' RTs as suggested by Greenwald, Nosek, and Banaji (2003; see also Lane, Banaji, Nosek, & Greenwald, 2007). In practice, this measure is similar to the effect-size measure, *d*. The incorrect response latencies were included in the calculation to check for possible differences in the results. In addition, an analysis of variance (ANOVA) was performed on the RTs, and a *t*-test was carried out on the error rates (%) in order to compare the accuracy between the two combinations for the two countries in which the experiment was conducted. Effects were considered significant when $p<.05$. Statistical analyses were performed using XLStat 2011 (Addinsoft, NY, USA).

2.2 Explicit colour association task

2.2.1 Participants. Participants were recruited through a mailing list based on their interest in participating in the study, taking into account that they were native British or Colombian or having been living in those countries for more than five years. After filtering the invalid responses, the data of 112 participants was considered for analysis. Fifty-six Colombian participants (38 female, M= 27.7 years; SD= 10), and 56 British participants (30 female, M= 32.6 years; SD= 12.2) took part in the experiment.

2.2.2 Stimuli. Three images of crisps packets were used as stimuli. The designs were based on existing commercial packets (unknown in either the British or Colombian markets). In addition, the brand name was replaced by an invented one, and the flavour information was replaced by invented or unknown flavours (for crisps) for both countries. The flavours were: "algas y sal" [seaweed and salt], "atún y mayonesa" [tuna and mayo], and "foie e higos" [foie and figs]. The English terms were used in the experiment carried out in the UK (see Figure 5.4 for examples). The designs of the labels were kept as simple as possible in order to avoid having other factors from

influencing the respondents' associations. The images were presented in electronic format (72 ppp; 15 cm high by 10 cm wide), and were presented on the screen against a white background.

Figure 5.4. Examples of stimuli showed for the explicit colour association task; a) to the Colombian participants; and b) to the UK participants.

2.2.3 Procedure. The participants were instructed to complete an electronic questionnaire with a colour association task with the three packets as stimuli. Instructions given to the participants were as follows: "Please write in the boxes below the first colours that come to your mind when you see the following packages." Three boxes were provided where they could write as many words they required. The task could be completed in less than 1 minute, though no time restriction was imposed.

2.2.4 Data analysis. The elicited associations were analysed qualitatively. Colours referring to a similar tone were grouped (e.g., dark blue, navy), but no filtering by minimum frequency was conducted to see all the colours mentioned and how they linked with the flavours. A multiple factor analysis (MFACT; Bécue-Bertaut & Pagès, 2004) was performed on the frequency table of the categories for each country to study the possible differences in their associative patterns (Bécue-Bertaut & Lê, 2011). The statistical analysis was performed using FactoMineR (R Development Core Team, Rennes, France) in R language (R Development Core Team 2007, Vienna, Austria).

3. Results

3.1 IAT

A summary of the IAT effects are illustrated in Table 5.3. *D*-measures were calculated excluding the error response latencies. Positive and negative values signify an

incongruent and congruent association with Combination 1, respectively. The higher a positive value or the lower a negative value, the stronger the association with Combination 2 or Combination 1, respectively.

Table 5. 3. Mean IAT effects.

Country	Mean latencies in ms (SD)		D-measure	Error rates in % (SD)	
	Comb. 1	*Comb. 2*		*Comb. 1*	*Comb. 2*
UK (a)	587 (215) [cd]	633 (224) [b]	-.36	3.0 (1.8)	5.6 (2.9)
UK (b)	597 (177) [c]	560 (157) [d]	.18	1.2 (2.9)	0.7 (2.6)
Colombia	685 (205) [a]	646 (199) [b]	.22	6.8 (3.0)	3.4 (2.1)

Values with different superscripts in the mean latencies are significantly different ($p<.05$) according to Tukey's test.

As shown in Table 5.3, the mean *D*-measure for the Colombian participants was positive (*D*-measure =.22). In contrast, the mean score for the British participants was negative (-.36) when the incongruent block involved pairing the colours with the switched flavours (as in Table 5.2a). However, for the blocks that involved pairing the colours with the Colombian flavours the *D*-measure was, unexpectedly positive, .18.

The results of the ANOVA revealed a significant effect ($p<.0001$) on the associative patterns exhibited by the participants from the two countries. A significant interaction between country and colour-flavour combination was also observed ($p<.0001$). Tukey's test revealed significant differences ($p<.001$) between the mean RTs of Colombian and British participants for each combination of stimuli (see Table 5.3). The Colombian participants found it easier to link what in their minds was a "congruent" combination (Combination 2), hence responding significantly more rapidly ($p<.0001$) when pairing accurately *natural* with blue and *limón* with green, than *cheese and onion* with blue and *salt and vinegar* with green. Surprisingly, as the positive *D*-measure indicated, the exact same pattern of results was also documented for the British participants. That is, they responded significantly more rapidly when they had to pair *lemon* with green and *plain* with blue (this was hypothesised to be the incongruent combination), than when they had to pair them with the flavours according to their regular brand of crisps (see Table 5.2b). However, for those blocks of trials where the flavours and colours where simply reversed (as in Table 5.2a), the results remained as reported in Piqueras-Fiszman and Spence (2011): that is, participants found it easier to associate *cheese and onion* with blue and *salt and vinegar* with green, than the other way around.

The total error rates were calculated for each combination and for each cluster of consumers (see Table 5.3). The accuracy of both cohorts differed significantly ($p<.05$)

from one combination to the other, with Colombian participants performing significantly better when they had to pair the colour-flavour combination as found in the crisps packets of that brand sold in their country. Regarding the British participants, in task (a), they committed more errors for Combination 2, but in task (b) the number of errors was much smaller, meaning that both types of stimulus combination were similarly easy and congruent. As for the increase in the number of word-stimuli, including four instead of two did not increase the difference in the RTs between stimulus combinations, meaning that participants did not find it any more complex. However, the fact that participants found the colours and flavours in both combinations similarly easy to associate might have counterbalanced this possible complexity.

3.2 Explicit colour association task

The results of the MFACT performed on the data from both countries' revealed that the three flavours elicited similar colours in the minds of the two cohorts of participants (see Figure 5.5a) and that they perceived the three flavours in similar ways (see Figure 5.5b).

Figure 5.5a. MFACT representation of the colours for both countries and the flavours as a consensus.

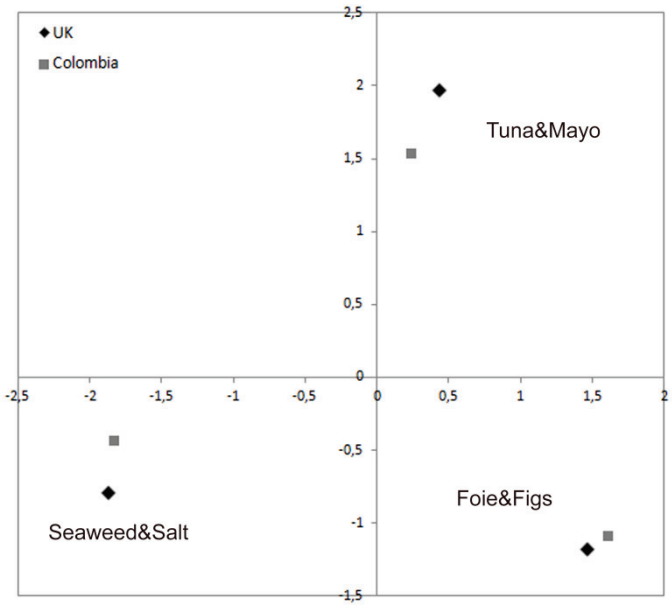

Figure 5.5b. MFACT representation of the flavours as perceived by the two countries.

For example, it can be seen that the flavour *Foie &* Figs, was associated with burgundy, browns, and yellowish tones. Meanwhile, *Tuna & Mayo* was clearly associated with salmon, cream, silver and pink colours in both countries, but also to light blue in the case of the British consumers. *Seaweed & Salt* was associated with blue and green tones, and to black, in the case of the British consumers. These results therefore evidence a consensus in the colour-flavour associations in the participants of both countries, with the colours being strongly related to those of the actual foods/ingredients involved. The rest of the colours plotted in the central areas of the map were those that were mentioned more commonly regardless of the flavour.

Figure 5.6 (a, b, c) shows the most frequently elicited colours for each flavour and country, where some relevant differences in the number of mentions can be seen, such as the purple, brown and orange colours in the *Foie & Figs* flavour, the white, pink and blue in the *Tuna & Mayo* flavour, and green, dark green, and yellow for the *Seaweed & Salt* flavour. However, this differences might also be due, in some cases, to the fact that some people expressed the tone (dark or light), while others did not. As mentioned earlier, the intention was not to filter important information, such as the tone, hence when the same colour was mentioned but with a different tone, it was not grouped.

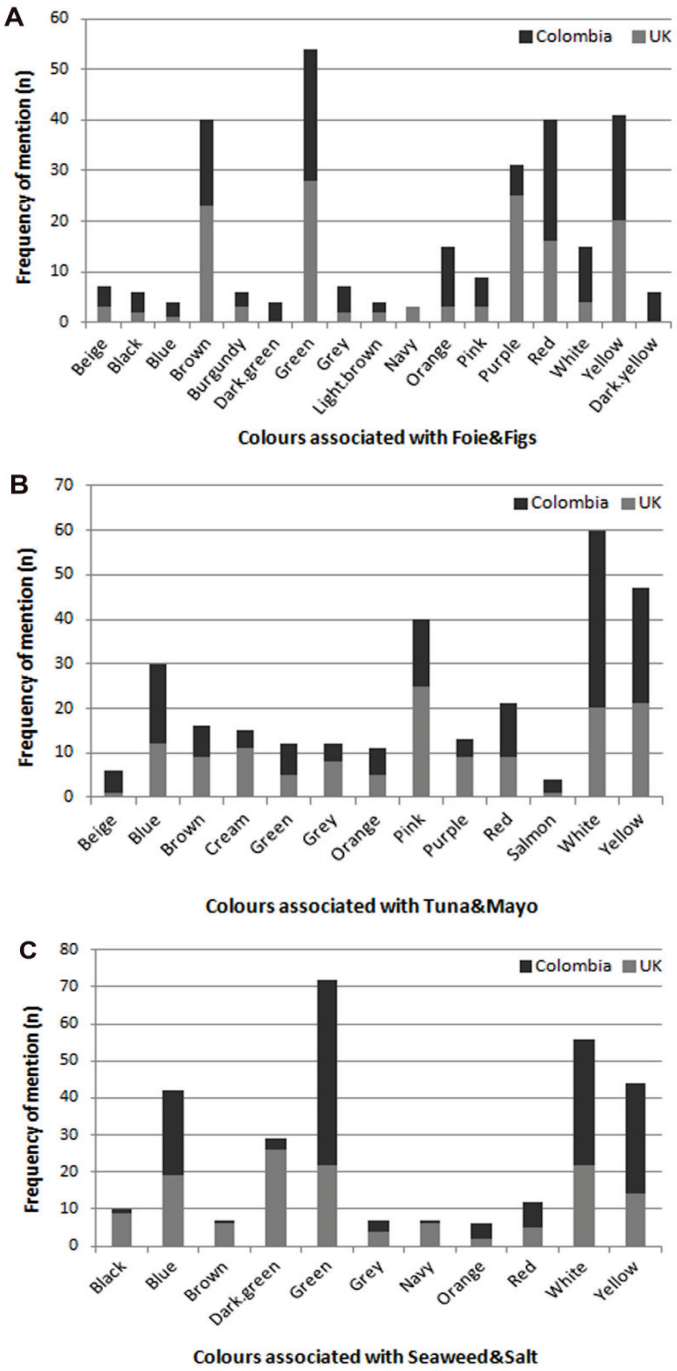

Figure 5.6. Frequency of mention (n) of the colours associated to: a) Foie & Figs; b) Tuna & Mayo; and c) Seaweed & Salt flavours for each country. The graphs only show those flavours mentioned at least three times in at least one country.

4. Discussion and conclusion

This study was designed to investigate whether consumers associated, implicitly and/or explicitly, specific flavours with specific colours on product packaging and to asses any differences between the crossmodal associations of consumers in the two countries.

Taken together, the results evidence two kinds of crossmodal associations: The first IAT results support the notion that packaging colours in the food and beverage sector may have specific associations (in terms of flavours) that can be particularly culturally specific, but *only* when linked with brand knowledge. When the colour-flavour combinations used in the other country was used as 'incongruent' combination, the participants from both countries associated faster and more accurately the flavours with the corresponding colours found in the packets of their usual brand, available in their own countries.[2] Nevertheless, thus far, our results simply demonstrate the influence of brand acquaintance on the colour-flavour matching in each country, essentially replicating the results of Piqueras-Fiszman and Spence (2011).

However, when the British participants had to pair the green and blue packets with *lemon* and *plain,* respectively, they found both combinations relatively easy to match, given that in one block the colour-flavour match was that of the brand they usually consumed, and in the other, the colours matched with the flavour's food. In fact, some of the participants reported on the ease of the task, by reasoning: *"lemons are sometimes greenish, and blue is like water, tastes plain"*. These last results suggest that if the colours of packages represented the colour of the flavour's food, associations in the consumers' minds would presumably be somewhat easier, and hence they would aid in product recognition.[3]

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[2] It should be noted that even differences of as little as 50 ms, as presented here, provide a relevant measure of an association (see Maison, Greenwald, & Bruin, 2004). Furthermore, it is also important to note that RTs and error rates that may seem quite small when tested in the laboratory can potentially have larger effects in terms of consumer behaviour in the marketplace (cf. Ho & Spence, 2008) because in the laboratory setting, the environment / stimulus display is typically very uncluttered. Hence, all stimuli that are presented are pretty soon processed by participants. Contrast that with the real world supermarket aisle, say, where there may be hundreds of products competing for one's limited attention.

[3] Different word lengths might have facilitated the task in favour of the shortest word stimuli, but in a pilot study with the terms "lemon & parsley" and "sea salt" (paired with the green and blue packets, respectively), the results demonstrated that this colour-flavour combination was still equally easy for them (589 vs. 579 ms, for Combination 1 and this pilot combination, respectively), thus demonstrating that the interpretation of the results wouldn't have varied too much as a function of word length.

The explicit colour-flavour association task with new flavours as stimuli (at least flavours that are certainly not widely associated with crisps in those countries), supported this other "logical" association, demonstrating that when consumers are asked about the first colours that come to mind when they see an uncoloured packet of crisps with a flavour, the colours more frequently elicited were those of the ingredients that contribute directly to the flavour. Other colours, such as gold or black, in the case of the *Foie & Figs* flavour, could be related to the associated status of the overall product (i.e., premium, or cheap). In any case, as shown in Figure 5.5, the two countries did not differ much in terms of the particular colour-flavour associations that they generated. These last results present another type of association, a more natural one, one that is not linked specifically with brand knowledge but instead with internalized knowledge concerning a food's typical colour.

Many food industries, including those who manufacture crisps, have a number of flavour varieties across countries as a product customization strategy, and often change and launch new flavours. However, when the colour of the packaging is used to identify specific flavours, it would obviously be helpful if they were to be recognizable by the majority of consumers at (at least) an implicit level, specifically the new launches, and not chosen in an arbitrary manner. For this reason, it is advised to collect knowledge regarding how consumers associate colours and flavours, and in which ways, depending whether it is a new product launch, a new brand, or simply a change within a product of an established brand.

Those consumers who are already well-acquainted with a particular brand of a certain product, will most likely easily recognise the flavour they want from the shelf just by looking at the colours of the packaging. However, for those consumers who have no particular brand preference, bearing in mind that a colour that hints the flavour makes the flavour more easily identifiable could make a difference in terms of product research. In addition other factors causing colour-flavour correspondences (apart of the colour of the food, and the brand), should also be given important consideration. For instance, certain foods are linked with specific colours, mainly because of the 'quality' connotations they convey, such as price and status (e.g., foie and caviar being linked 'luxury', which is generally associated with black or golden colours, in most occidental cultures). These connotations are more likely to give rise to more diverse correspondences as a function of culture, overall if the cultures greatly differ, which perhaps was not the case here. Hence more research should be carried out delving into the qualitative connotations that some foods might transmit and the colours that

those meanings potentially elicit in consumers' minds. To achieve this, it would be more appropriate to use an IAT which included emotional, hedonic, and/ or quality-related terms, together with a range of colours (in the packaging images), ideally with projective tasks similar to the colour association task used here.

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6 A matter of weight: Relations between weight, quality, and price

The weight of the bottle as a possible extrinsic cue with which to estimate the price (and quality) of the wine? Observed correlations

Piqueras-Fiszman, B. & Spence, C. (2012). The weight of the bottle as a possible extrinsic cue with which to estimate the price (and quality) of the wine? Observed correlations. *Food Quality and Preference, 25,* 41-45.

Abstract

We report a study designed to assess whether there is any 'weight' to the claim that better (or, at the very least, more expensive) wines come in heavier bottles. A field study was conducted in an independent wine retailer in which we looked for correlations between weight, price, and a range of other explanatory variables. The data concerning 275 wine bottles from 5 countries were analysed. An internet-based questionnaire was also conducted in order to assess the beliefs that 150 Spanish consumers hold about the relationship between the weight of the bottle and the quality (and price) of the wine. The results revealed that the weight of the wine bottles correlated positively and significantly with the price of the wines; the significance level of this correlation varied by country. In addition, the weight of the bottle was also correlated with a number of other properties of the wine, including its vintage, colour, and alcohol content. These findings suggest that consumers can extract potentially useful information by simply 'feeling' the price of the wine (i.e., by holding the bottle in their hands). The results of the questionnaire revealed a consumer trend toward associating the weight of the bottle, the price of the wine, and its quality.

Keywords: Wine bottle; quality perception; price expectation; product extrinsic cues; crossmodal interactions; multisensory perception

1. Introduction

When shopping for wine, consumers often have a very wide range of different products to choose from (Britton, 1992; Rocchi & Stefani, 2005). Since consumers usually cannot taste wine at the point of purchase, their assessment of its quality, and hence their ultimate purchase decision, is typically based on the product extrinsic quality cues (such as brand name, price, advertisement, labeling, etc.; Lockshin, Jarvis, d'Hauteville, & Perrouty, 2006; Olson, 1997), rather than on the product intrinsic quality cues (that is, the sensory characteristics of the wine itself; Grunert, Hartvig Larsen, Madsen, & Baadsgaard, 1996).

According to Rocchi and Stefani (2005), consumers consider two main attributes of wine bottles when making their purchasing decisions. The first relates to the bottle's shape, size, and colour; whereas the second dimension concerns the type of closure and label. However, most published studies dealing with the influence of these product extrinsic parameters on the perception of wine by consumers have focused on the influence of the labeling (i.e., label information, imagery, layout, and colour). Though the label of the wine bottle has been shown to provide information about the sensory attributes and quality of the wine contained within (Puyares, Ares, & Carrau, 2010; Verdú Jover, Llorens Morente, & Fuentes Fuentes, 2004), there are not so many studies concerning the influence of the characteristics of the bottle (as opposed to those of the label or closure) on consumers' expectations of wine quality.

It is well-known that in many product categories consumers associate heavier products with better quality (e.g., Jostmann, Lakens, & Schubert, 2009; Lindstrom, 2005; Piqueras-Fiszman, Harrar, Alcaide, & Spence, 2011; Piqueras-Fiszman, & Spence, 2011; Spence & Gallace, 2011; Spence & Piqueras-Fiszman, 2012). Wine bottles constitute one such class of product where this relation is believed to hold true. The first 'modern' wine bottle patented was dark, strong, and heavy (according to Estreicher, 2006). The technological innovation that enabled the production of such bottles soon extended throughout many wine-growing regions, supplanting the crafted delicate bottles that had previously been considered as a luxury. However, the symbolic qualities (e.g., the expression of luxury) associated with the glass bottles still remain, despite the fact that they are now widely available.

The popular wine press sometimes likes to suggest that certain wine producers are 'tricking' wine consumers into thinking that the wine is of a higher price (and better quality) simply by packaging it in a heavier bottle. For instance, take Goldstein and

Hershowitz's (2010, p. 80) claim that: *"These Bogle bottles are hefty, and their weight is a nice feature – one that often tricks people into thinking the wine is more expensive than it really is."*

Nowadays, wine bottles display a wide variation in weight. According to research from WRAP (Waste & Resources Action Programme, 2006, www.wrap.org.uk), the weight of a 75cl (approx. 750g) wine bottle varies between 300g and 900g (though the authors have come across a bottle of red wine from Argentina of 1,180g), with the average weight falling in the region of 500g. The reason behind such variability in the marketplace is not altogether clear from a consumer perspective. In 2006, Faraday Packaging and Glass Technologies investigated the specific associations that consumers had with the weight of glass bottles (including wine bottles). They also investigated whether light-weighting was perceptible to consumers, and for which classes of product this might be regarded as an acceptable marketing strategy. Their results revealed, as expected, that in the case of wine, consumers had associations between the weight of the glass bottle and the quality of the product within, the heavier the better. This was most apparent for premium goods. By contrast, the pattern was nothing like as strong for 'value' products where the weight of the packaging was not considered by consumers (at least not on a conscious level) to any great extent.

What is more, in a psychophysical study (http://www.glass-ts.com/Consultancy/ConsultancyPDFs/ContainerLite_Lightweight__WRAP_TZ969_-_2006_.pdf), 32 participants were asked to pick up two bottles of vodka from a shelf, one of 300g and a heavier one of 500g, both filled with 70cl of vodka, one after the other. Of the 14 participants who noticed the weight difference, 9 preferred the heavier bottle, which was perceived as being stronger, more expensive, of better quality and elegance, and being more 'up market'. Note, though, that no statistical analyses were performed on the results in order to determine whether or not these differences were significant. Generally-speaking, when the weight difference was noticed, more attention was given to the characteristics of the container, and the heavier bottle was viewed more favourably.

But is the claim really true? That is, does the weight of the bottle actually provide a good indicator of the price (and hence, perhaps, also the quality) of the wine contained within? There is as yet no scientific evidence on this question as far as wine bottles are concerned. Of course, there is certainly a cost associated with

lightweighting: Lighter bottles tend to be weaker and more likely to break during their transportation, so stronger bottles are usually preferred to protect the product, especially in the case of expensive wines. On the other hand, the heavier the bottle, the greater the cost of the raw packaging materials. Even when it comes to comparing a £15 wine with a wine costing no more than £5, some people still rely on the heaviness of the bottle as an indicator of quality (see www.thirtyfifty.co.uk/spotlight-environment-and-wine.asp). This may be because consumers believe that the increment in the cost of the glass is small when compared to the wine's value and the risk of breakage. But, for wines selling below the £5 mark, this is a less significant factor. According to WRAP, there is no relationship between the purchase price of a wine below £5 and the weight of the bottle. Therefore, WRAP advocated a shift to 300g bottles for wines selling for under £5 (some are 750g) in order to reduce the amount of waste produced by wine bottles in the household waste stream (this issue is especially important given current global environmental concerns).

There are a number of different hypotheses as to the key factors that may ultimately contribute to the weight of a wine bottle. It is possible, for example, that people expect red wines to be sold in heavier bottles than white wines. It has also been suggested that the weight of the bottle may vary as a function of the vintage, and as a function of whether the wine comes from the Old World (e.g., those produced in the traditional European wine-growing countries, i.e., France, Germany, Italy, and Spain) or the New World (including Argentina, Australia, Chile, South Africa, and the USA). However, the weight of the wine bottle can be manipulated by varying the thickness of the glass and/or altering the depth of the punt (in the wines measured in this study the depth of the punt varied from bottles where it was virtually non-existent through to bottles where it reached in excess of 5cm).

Given the lack of certainty surrounding the actual relationship between the weight of the wine bottles and the characteristics of the wine that they contain, the goals of the present study were: 1) To determine whether there is a correlation between the weight of the wine bottle and its standard retail price; 2) To look for any correlations between the weight of the wine bottle and its vintage, colour, and country of origin; 3) To assess how much variation there actually is in the marketplace in terms of the weight of a 75-cl wine bottle; 4) To check for any correlations between the weight of the bottle and whether the wines come from the New World versus Old; and 5) To investigate (by means of an online questionnaire) the beliefs that wine consumers

have concerning the weight of wine bottles and its relationship with the quality and price of the product within.

2. Materials and methods

The study was conducted in a wine store in Oxford (www.oxfordwine.co.uk). In excess of 500 wine bottles (over 90% of the stock in store) were weighed with a common calibrated digital kitchen scale and the main characteristics of the wine noted. Table 6.1 provides a summary of the variety of wines taken into account in the analysis of this study (n=275).

Table 6.1. Summary of the main characteristics of the wines considered in the study.

	Red	White	Total
Australia	**36**	**21**	**57**
£5-15	21	19	40
£16-25	6		6
£26-35	9		9
<2005	*5*		*5*
2005-2007	*11*	*8*	*19*
>2008	*20*	*13*	*33*
France	**36**	**24**	**60**
£5-15	20	20	40
£16-25	10	4	14
£26-35	6		6
<2005	*1*		*1*
2005-2007	*18*	*4*	*22*
>2008	*17*	*20*	*37*
Italy	**39**	**19**	**58**
£5-15	14	18	32
£16-25	15	1	16
£26-35	10		10
<2005	*6*		*6*
2005-2007	*13*		*13*
>2008	*20*	*19*	*39*
South Africa	**29**	**22**	**52**
£5-15	19	18	38
£16-25	8	3	11
£26-35	2	1	3
2005-2007	*10*	*1*	*11*
>2008	*19*	*21*	*41*
Spain	**36**	**13**	**51**
£5-15	16	9	27
£16-25	13	4	17
£26-35	7		7
<2005	*11*		*11*
2005-2007	*12*	*3*	*15*
>2008	*13*	*10*	*25*

In addition, to gain insights on people's general opinion about the relationship between the price and quality of wine and the weight of the bottle, an online questionnaire was also delivered in Spain among wine experts, agronomy and food technology institutes and departments, and the general public. However, in the recruiting email it was mentioned that the purpose was to collect information about general wine consumption, preference, and knowledge. The questionnaire first asked the participants about their subjective categorization of their own wine expertise (giving them three options: naïve, amateur, or expert), their familiarity with wine, their frequency of consumption, and their preferred variety of wine. Only the data of those respondents who consumed more than one glass of wine per week were considered for further analysis (150 consumers; see Table 6.2). The next two questions asked: "Please rate your opinion of the following statements". The statements were: "More expensive wines come in:" and "Higher quality wines come in:" They were asked to rate on 9-point Likert scales anchored in the extremes with "Lighter wine bottles" and "Heavier wine bottles". There was also an external checkbox labelled "I don't know" available to mark.

Table 6.2. Demographic information of the Spanish individuals who completed the online questionnaire and were considered for the analysis.

	Number of respondents (n)
Total	150
Gender distribution	
Male	58
Female	92
Age range (years)	
20-40	99
41-60	42
>60	9
Self-reported expertise	
Naïve	62
Amateur	56
Expert	32
Frequency of consumption	
1-2 glasses of wine a week	23
Up to 5 glasses of wine a week	56
1-2 bottles a week	52
More than 2 bottles of wine a week on average	19

2.1. Data analysis

For the online questionnaire, an ANOVA was performed on the two sets of data individually considering the consumer groups (according to their wine expertise) as fixed source of variation. In addition, one sample *t*-tests, with 5 (the mid-point of the scale) as the test value, were conducted on each scale and for each consumer group.

An ANOVA was performed on the weight data for all countries, considering country, colour, and their interaction as sources of variation. In addition, Pearson's correlation tests were performed on all data considering the weight of the bottle, the price, the vintage, the alcohol content, and the colour of the wine. These correlations were also analysed separately by the country of origin of the wines. The quantitative data were introduced into the analysis as single (original) values and treated as continuous variables.

When the effects were significant, honestly significant differences were calculated using Tukey's test. Differences were considered significant when $p \leq .05$. Statistical analyses were performed using XLStat 2011 (Addinsoft, NY, USA).

3. Results

3.1. Wine consumers' beliefs

All of the consumers responded using the scales (i.e., no one ticked the "I don't know" checkbox). It can be seen that in general, people thought that the weight had to do more with the price than with the actual quality of the wine. As shown in Table 6.3, significant differences were found among the consumers groups' ratings of their beliefs regarding the relationship between the weight of the bottle and the price or quality ($p<.001$); hence naïve consumers had significantly different opinions about it in comparison to both the amateurs and experts ($p>.05$ between the latter pair). Naïve consumers scored significantly higher (hence significantly further away from the mid-point value, $p<.001$, as well as the amateurs) for both attributes. Although the quality-related ratings of the experts were the ones closer to the mid-point value (and not significantly different from it, $p=.083$), the ratings related to price were significantly different from the mid-point ($p<.01$). The range of ratings of the naïve consumers was the widest, while the range of ratings documented in the experts was the least widespread. In any case, the results would appear to indicate some trend to relate more expensive and higher quality wines with heavier bottles, at least for the naïve consumers.

Table 6.3. Mean scores (SD) of the consumer questionnaire concerning the relation between the weight of the wine bottle and the price and quality of the wine.

Consumer self-classification	Price	Quality
Naïve (62)	7.1[a] (.56)	6.6[a] (.61)
Amateur (56)	5.5[b] (.57)	5.3[b] (.58)
Expert (32)	5.2[b] (.43)	5.1[b] (.29)
Total (150)	*6.1 (1.00)*	*5.7 (.86)*

Values for the groups with different superscripts within one column indicate that average scores are significantly different according to Tukey's test ($p \leq .05$).

These findings suggest that the majority of individuals who answered this questionnaire would presumably not explicitly (that is, consciously) rely on the weight of the bottle of wine as an indicator of its price or quality. However, that said, it may still be the case that the weight of the bottle might have an impact at a more implicit (or sub-conscious) level, and/or in a psychophysical study (Mueller, Lockshin, & Louviere, 2009).

3.2. Results of the analyses of all the wines

3.2.1. Overall results. The weight of the wine bottles was positively correlated (r=.512; $p<.001$) with the price of the wines when all the wines (i.e., regardless of country) were assessed together (see Figure 6.1), and inversely correlated (r=-.328; $p<.01$) with the vintage of the wine.

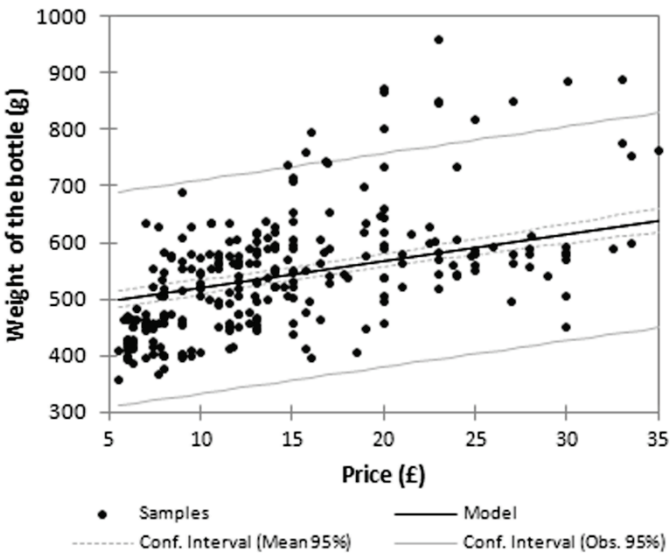

Figure 6.1. Weights of all the wine bottles as a function of price.

Put simply, it would appear as though younger wines tend to be sold in lighter bottles in most countries. In addition, the alcohol content of the wines was also found to be positively correlated (r=.332: $p<.01$, overall) with the weight of the bottles (see Table 6.4).

Table 6.4. Correlations (Pearson's coefficient) between weight and price, alcohol content, and vintage for wines ordered alphabetically by country of origin.

	Price	% Alcohol	Vintage
Australia	.272	.037	**-.330***
France	**.432****	**.441****	**-.363****
Italy	**.754****	**.736****	**-.512****
South Africa	**.830****	.199	**-.482****
Spain	**.494****	**.313***	-.227
Total	**.512****	**.332****	**-.328****

*Significant effect at $p<.05$; **Significant effect at $p<.001$

Interestingly, on average, red wines had a higher alcohol content (M=13.8%) than the whites (M=13.0%). This is also related to the fact that the results of the ANOVA performed on the weight data revealed that the colour of the wine was significantly related to the weight of the bottle ($p<.001$). In general, bottles of red wine were found to be significantly heavier than the white wine bottles (567g vs. 529g, $p<.01$). However, this variability was not significantly different as a function of the country of origin ($p>.05$), and no interaction effect was found ($p>.05$). Furthermore, in the case of the Spanish wines, the whites were, on average, slightly heavier than the reds (see Figure 6.2).

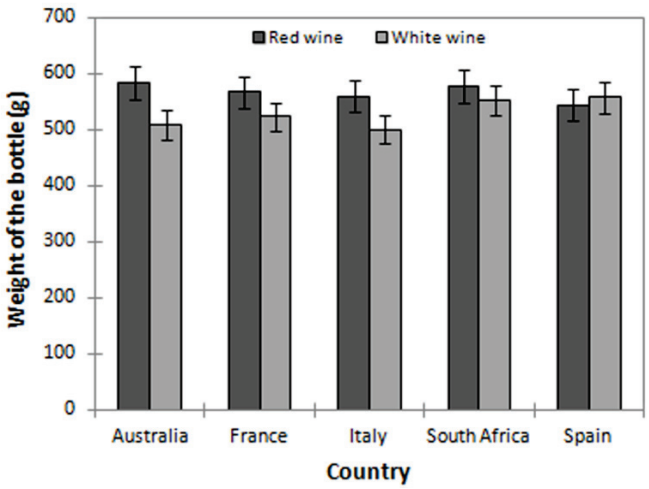

Figure 6.2. Mean weights of red and white wine bottles across countries. Vertical bars represent Tukey's HSD at $p<.05$.

Here, it is also worth highlighting the difference in weight that was found between the heaviest and lightest wines bottles across colour and countries, most of which varied by more than 40% (taking the heaviest bottle measures as reference). The greatest differences were found in the Spanish wine bottles, where a 62.6% difference was observed between the heaviest and lightest white wine bottles followed by a 58.7% for the red wine bottles. The country with the second biggest difference between the weight of the wine bottles was Australia, with a difference of 56.8% (see Table 6.5). The heaviest wine bottles were from Spain (962g, a white wine), Italy (902g), and South Africa (888g), which were reds.

Table 6.5. Differences between the heaviest and lightest bottles, in mean weights (in grams) and percentages with respect to the heaviest bottle.

	Red		White		Total	
	(g)	(%)	(g)	(%)	(g)	(%)
Australia	496	56.8	290	41.0	496	56.8
France	352	43.8	262	39.6	404	50.3
Italy	504	55.9	346	46.6	506	56.1
South Africa	492	55.4	458	53.8	494	55.6
Spain	522	58.7	602	62.6	602	62.6
Total	534	59.2	602	62.6	602	62.6

New vs. Old World. There were no significant differences ($p>.05$) in the weight (mean) of wine bottles between the New World wines (i.e., Australia, and South Africa) and the Old World wines (i.e., Italy, France, and Spain).

3.2.2. Results by country. Australia. Of the measured variables, the only one that seemed to be significantly related to the weight was the vintage ($r^2=.11$; $p=.05$), with the younger wines coming in lighter bottles than older wines. Though the price and the amount of alcohol were positively correlated, the correlations were not strong (cf. Table 6.4), and did not reach significance.

France. In the case of the French wines, their price and amount of alcohol ($r^2=.19$; $p<.001$ for both), were positively correlated with the weight of the bottle, in contrast to the vintage ($r^2=.13$; $p<.01$) which was negatively correlated, which means that bottles of wine from an older vintage weighted significantly more than younger wines.

Italy. In the case of the Italian wines, all the factors included in the model were significant ($p<.0001$) as well. Price ($r^2=.57$) and alcohol ($r^2=.54$) were positively correlated with the weight of the wine bottles, whereas the vintage was once again negatively correlated ($r^2=.26$; cf. Table 6.4).

South Africa. 68.9% of the variability in the weight of the South African wines was explained by the price ($p<.0001$), being positively correlated as well (cf. Table 6.4). The vintage of the wine was the only other factor that was significantly related to the weight ($r^2=.23$; $p<.0001$) and was negative correlated.

Spain. In the case of the Spanish wines, price was significantly related to the weight ($r^2=.25$; $p<.0001$). The results of the analysis revealed that the alcohol content ($p=.029$) had also a significant impact on the weight of the wine bottle, being positively correlated to it (cf. Table 6.4). However, the correlation with the vintage was not significant ($p=.116$).

4. Discussion

In summary, the results of the present study demonstrate that, generally-speaking, the weight of the wine bottles were correlated with the price of the bottle, though the extent varied by country and type of wine. It should, however, be noted that just because positive correlations between weight and *price* were documented, one should not immediately jump to the conclusion that there is necessarily a correlation between price and *perceived quality*, given the fact that, in blind tastings, there is no direct correlation between the price of a bottle of wine and its perceived quality, or rather how much people reported liking it when they drink it (see Spence, 2010, for a review). However, that said, there is a justification for packaging very expensive wines in heavier bottles to the extent that heavier bottles are less likely to break than bottles made of thinner glass (or with a shallower punt).

The results of the consumer questionnaire revealed that, in general, consumers (though mostly the more naïve sector) would be tempted to believe in a positive correlation between the price and quality of the wine and the weight of the bottle. The ratings from the three cohorts of respondents varied significantly, with those from the naïve cohort more strongly relating the weight of the bottle to the price and quality of the wine, this relationship decreased with the increasing wine expertise of the respondents. However, the respondents who considered themselves wine experts did not manifest any inclination to relate the weight of the wine bottle and its quality.

It is, however, important to note that the present study did not explicitly test whether consumers do actually rely on the weight of the bottle in order to estimate (probably at an unconscious level) the price and quality of the wine, or even if it affects the sensorial perception of the wine. To corroborate the claim that consumers believe if the wine they are drinking is of higher quality or more expensive, further research

would need to be conducted in which people actually rated the same wine when served from bottles having different weights (taking into account the consumers' wine knowledge and the price of the wine normally purchased). The prediction would be that a wine consumed from a heavier bottle ought to be perceived (all other things being equal) as of higher quality. However, it can also be argued that the weight of the wine glass might exert an important influence on people's judgments too, since previous research has demonstrated that the weight of the container affects the perceived quality and density of the contents (Piqueras-Fiszman & Spence, 2011; Piqueras-Fiszman *et al.*, 2011). The stimulus in these previous studies was yoghurt, which is typically not associated with luxury, or regarded as a high-end product, like wine. Hence, a stronger effect would be expected if the experimental design was to be replicated with wine bottles and/or wine glasses instead.

Furthermore, it would also be interesting to investigate whether people's perception of the weight of the wine bottle might also be influenced by crossmodal illusions such as the colour-weight illusion (Spence & Piqueras-Fiszman, 2012; Walker, Francis, & Walker, 2010). The prediction here might be that red wines ought to be perceived as heavier than white whites, given that the former will typically look darker.

One potentially important topic not covered in this study is the effect of the shape of the bottle. It might be possible that different shapes weigh different amounts. Similarly, Burgundy and Rhône varieties come in tall bottles with sloping shoulders and a smaller punt, whereas Bordeaux bottles have straight sides and angular shoulders. In addition, these differences in shape may also influence how we hold such bottles, hence potentially providing another means by which our perception of the weight of the wine bottle might be modified (Flanagan & Bandomir, 2000; Ross & Brodie, 1987; see also Spence & Piqueras-Fiszman, 2012). In addition, it would be also interesting to study how the format and size of the container affects the consumers' appraisal (feeling) and acceptance of the product within, given that 25-cl and PET wine bottles are starting to be commonly found in the marketplace in many countries in Europe.

In any case, a major concern about the weight of bottles for wine producers is that they could be reduced to 300g in order to save an estimated 20,000 tonnes of glass per year
(http://www.wrap.org.uk/retail_supply_chain/grocery/drink/wine/lightweighting.html). However, as some consumer studies have already demonstrated, holding a light wine bottle in one's hands simply does not feel as 'good' as holding a heavier one (see

Spence & Piqueras-Fiszman, in press, for a review). Therefore, some companies are aiming to gradually introduce a shift to 400g bottles in order to avoid consumers noticing the change.

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7 Crossmodal perceptual illusions

Is it the plate or is it the food? Assessing the influence of the colour (black or white) and shape of the plate on the perception of the food placed on it

Piqueras-Fiszman, B., Alcaide, J., Roura, E., & Spence, C. (2012). Is it the plate or is it the food? Assessing the influence of the color (black or white) and shape of the plate on the perception of the food placed on it. *Food Quality and Preference, 24,* 205-208.

Abstract

Our perception of food is affected by the sensory properties of the food itself, together with our expectations about the food and other contextual factors. The latter are especially relevant in the restaurant setting, where appearance factors, such as the presentation of the food on the plates can dramatically affect food liking and consumption. However, to date, not much emphasis has been placed on the effect of the appearance of the accessories on our perception of food.

The aims of the present study were therefore to test the extent to which the appearance properties of the plate influence the taste/flavour experiences of the food served on it. Specifically, we investigated the influence of the colour (black or white) and shape of the plate on the perception of flavour intensity, sweetness, quality, and liking for identical strawberry mousse desserts.

The results demonstrated that while the colour of the plate exerted a significant influence on people's perception of the food, the shape of the plate did not. In particular, when the mousse was served from a white plate, it was perceived as significantly more intense and sweeter, and was also liked more.

These results therefore demonstrate the importance of the colour (if not the shape) of the plate on people's perception of food.

Keywords: Food perception; colour influence; shape; flavour intensity; liking; consumer studies

1. Introduction

Our perception of food is primarily affected by the various sensory properties of the food itself, together with our expectations about it, and any contextual factors that may be relevant. A great deal of research has been carried out over the years in order to investigate the influence of all of these variables on the perception, both sensory-discriminative and affective, of a variety of different food and drink items. Flavour perception results from the combination of retronasal olfactory, gustatory, somatosensory, auditory, and trigeminal cues (Stevenson, 2009). Visual and orthonasal olfaction cues provide the greatest contributions in terms of our expectations regarding the flavour of food and drink. Hence, these senses also play an important contributory role in terms of flavour perception (Shankar, Levitan, & Spence, 2010), since in the majority of cases, these cues are available *prior* to consumption.

An extensive body of research has focused on the effect of visual cues on multisensory flavour perception (Spence, 2010). With regard to the influence of the appearance of the food on people's perception of its flavour, it is important to note that food colour often dominates over other sources of flavour information. Numerous studies have now been published demonstrating the profound role that colour can play in flavour perception across many different foods and drinks (e.g. see Spence, Levitan, Shankar, & Zampini, 2010, for a review).

To mention just a few studies on the effect of packaging's visual attributes on flavour perception, Cheskin (1957) anecdotally reported that when 15% more yellow was added to the green on 7-Up cans, consumers perceived the drink as tasting significantly more limey/lemony, naming this phenomenon *"sensation transference"*. Similarly, Deliza and MacFie (2001) demonstrated that varying the colour of juice packages led consumers to expect a higher level of sweetness, and consequently affect taste evaluations. Guéguen (2003) and Ross, Bohlscheid, and Weller (2008) also reported the influence of the colour of glass on the perception of the drink consumed from it (see also Delwiche & Pelchat, 2002; Hummel, Delwiche, Schmidt, & Hüttenbrink, 2003).

As for the influence of shape, a number of studies suggest that the presence of more angular shapes (be it the shape of packaging, or the graphics on it) can enhance the perception of certain attributes of the product contained within, like its flavour intensity (Becker, Van Rompay, Schifferstein, & Galetzka, 2011; Ngo, Misra, & Spence,

2011), or its carbonation, in the case of sparkling drinks (Spence & Gallace, 2011; see Spence, 2011, for a review).

Cognitive neuroscience has recently started to provide an explanation for why such sensation transference effects may occur. The explanation relates to the phenomenon of crossmodal correspondences (see Spence, 2011). The basic idea is that we share a number of associations between sensory attributes (either presented or simply just imagined) in different modalities. So, for example, people map sour-tasting and carbonated foods and beverages onto sharper shapes, whereas they preferentially map creamy foods and still liquids onto more rounded shapes instead. In turn, these crossmodal correspondences between taste/flavour/oral-somatosensation and shapes, colours, etc. can be used on product packaging in order to set up expectations (often unconscious) concerning the sensory qualities of the contents contained within that packaging. That is, if you see a product in angular packaging, or with an angular-shaped label, or even with just an angular shape on the label then your brain may immediately set-up an expectation (or prediction) about the likely qualities of what is inside.

With regard to the colour of food and the colour of the immediate surroundings in which that food happens to be presented (i.e., the colour of the dish/cup, etc.), there are also contrast mechanisms that may help to explain our perception of certain "illusory" colours. For instance, the orange of a carrot might well be intensified if it were to be served on the same blue plate due to the phenomenon of simultaneous contrast (Hutchings, 1994; Lyman, 1989). To date, no evidence has been reported to assess what consequences such differences in perceived colour might have for flavour perception. However, it might be expected that if the colour of the plate (or background) affects the way in which people perceive the colour of the food (Ekroll, Faul, & Niederée, 2004; Hutchings, 1994), and the colour of the food is known to affect the perception of flavour, then the colour of the plate (and any contrast effect that it elicits) might be expected to influence the perceived properties of the food (e.g., the flavour intensity, etc.).

Hence, in this context, and given recent findings concerning the existence of crossmodal correspondences, it could be argued that identical foods might well taste different when served from plates of different shapes and colours. Could it be, then, that a food might actually be perceived as having a more intense flavour when served

from an angular plate rather than from a rounded one, or, say, from a black plate rather than a white one?

The present study investigated the influence of the plate's colour (black vs. white) and shape (i.e. round, square, or triangular) on the perceived sweetness, overall intensity, quality and liking of a strawberry flavoured mousse.

2. Materials and methods

Two experiments were carried out at the Alicia-elBulli Foundation (a gastronomic research centre founded by chef Ferrán Adrià in Barcelona, Spain).

2.1. Experiment 1. Colour of the plate

2.1.1. Food stimulus. A strawberry mousse was prepared according to the following proportions per liter of cream (35% fat): 1L of strawberry purée, 125g of white sugar, and 24 g of gelatin. The mousse was presented in the shape of a half- sphere.

Colour measurements. The CIELAB parameters (L*, a*, b*, C^*_{ab}, h_{ab}) for the strawberry dessert were determined following the recommendations of the Commission Internationale de L'Eclairage (CIE, 2004). The measurement was carried out with a Konica Minolta CM-35000d spectrophotocolourimeter. Three replicates of each sample were conducted. The results were expressed in accordance with the CIELAB system with reference to illuminant D65 and a visual angle of 10º (Hutchings, 1994). The colour measures for the mousse are presented in Table 7.1.

Table 7.1. Colour measure of the strawberry mousse.

	L*	a*	b*	C_{ab}*	h_{ab}
Mean (SD)	66.14 (.16)	15.83 (.33)	2.46 (.10)	16.03 (.31)	8.85 (.53)

L*= lightness; a*=greenness/redness; b*= blueness/yellowness; C*=chroma; h=hue.

2.1.2. Plates. Black and white plates were used, since they are the most commonly used in restaurant settings (Figure 7.1). They were of the same material, shape, and size (porcelain, rounded, and 28 cm in diameter). Though, strictly-speaking, black and white are not considered as colours, they will be referred to as such for the sake of ease of exposition.

Figure 7.1. Picture of the mousse presented on the black and white plates.

2.1.3. Participants. Fifty-three volunteers participated in the experiment, 34 of whom were female. The participants were randomly recruited at the Alicia Foundation, based on their interest in participating in the study. In addition, care was taken to ensure that they did not suffer allergies to the ingredients used in the food stimuli. At the recruitment stage, no information about the specific aims of the study was provided. Participants ranged in age between 20 and 59 years old (mean 34 years, standard deviation 9 years).

2.1.4. Procedure. Instructions were given to the participants before starting. The same strawberry mousse (55 grams at 10ºC) was presented to consumers on black and on white plates, as shown in Figure 7.1. The experimental procedure followed a balanced presentation order (MacFie, Bratchell, Greenhoff, & Vallis, 1989), that is, half of the participants received the black plate first, while the other half received the white one first. The participants, in groups of four, were instructed to taste one spoonful of the sample from one plate and then fill in four pencil-and-paper scales, before trying the next sample (monadic sequential scheme). The participants were seated separately from each other at a long table and were instructed not to comment aloud during the course of the experiment. What is more, they were not allowed to lift or touch the plate.

Unstructured 10-cm-long scales were used to rate perceived sweetness, flavour intensity, and quality of the strawberry mousse sample, anchored with “not sweet at all” and “very sweet”, “not intense at all” and “very intense”, and “very low quality” and “very high quality”, respectively. To rate liking, the participants had to score their overall liking using a 9-point hedonic scale, anchored with “dislike extremely” and “like extremely”. A cup of natural bottled water was available for rinsing between samples. The participants were allowed to finish the mousse after they had completed the

evaluation if they so wished. Evaluations were performed under artificial daylight type illumination, temperature control (22-24ºC) and air circulation.

2.2. Experiment 2. Shape of the plate

2.2.1. Food stimulus. The same strawberry mousse was used as the stimulus as had been used in Experiment 1; however, in this case, it had the shape of a pyramid.

2.2.2. Plates. White plates of the same material (porcelain) and similar in size (approximately 28 cm wide) were used. One was triangular, one squared, and the third rounded in shape (Figure 7.2).

Figure 7.2. Picture of the mousse presented on the square, round and triangular plates.

2.2.3. Participants. Fifty-one volunteers participated in the experiment, 27 of whom were female. The participants were randomly recruited at the Alicia Foundation, based on their interest in taking part in the study. At the recruitment stage, no information about the specific aims of the study was provided. Participants ranged in age between 19 and 59 years old (mean 33.8 years old, standard deviation 10.2 years).

*2.2.4. Procedure***.** Before starting, the participants were given instructions on the procedure to be followed during the study. The strawberry mousse samples (35 grams at 10ºC) were presented to consumers on the three differently-shaped plates, as shown in Figure 7.2, following the same balanced presentation order described in section 2.1.4. (MacFie *et al.,* 1989). The participants, now in groups of six, were instructed to taste the sample from one plate and then to fill in the same four scales as described in Section 2.1.4., before trying the next sample. As in Experiment 1, natural mineral water was available for rinsing between samples. The participants were again instructed to try one spoonful of each mousse during the evaluation, and the type of spoon was the same for all participants. Experiment 2 was carried out under the same environmental conditions as Experiment 1.

After collecting the data from both experiments, all participants were fully debriefed as to the nature and purpose of the experiment.

2.3. Data analysis

In order to determine whether the shape and colour of the plates exerted a significant effect on the perceived flavour intensity, sweetness, quality, and overall liking scores, a repeated measures analysis of variance (ANOVA) was performed on the data considering these factors as dependent variables. In Experiment 1, the colour of the plate (black or white) was considered as a fixed source of variation; for Experiment 2, the shape of the plate (triangular, square, or round), was considered.

When the effects were significant, honestly significant differences were calculated using Tukey's test. Differences were considered significant when $p \leq .05$. Statistical analyses were performed using XLStat 2010 (Addinsoft, NY, USA).

3. Results

3.1. The effect of the colour (or contrast) of the plate

According to the results of the ANOVA, the colour of the plate exerted a significant effect on consumers' perception of flavour intensity ($p<.001$), sweetness, and liking (both $p<.05$), suggesting that the participants perceived the mousse on the plates differently.

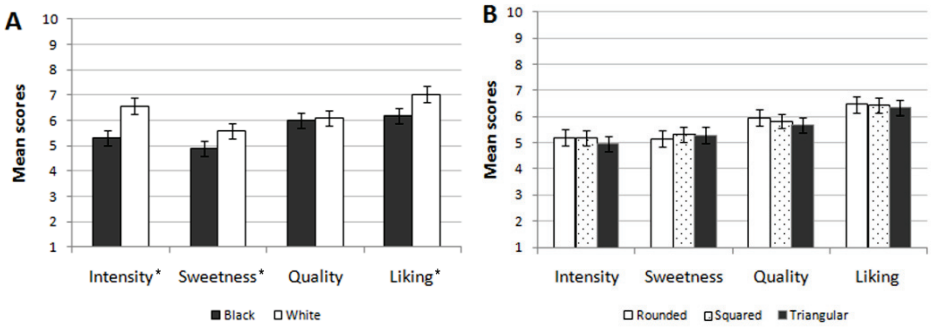

Figure 7.3. a) Mean perceived (intensity, sweetness, quality and liking) and sem, for the mousse presented on black, or white plates; and b) Mean perceived (intensity, sweetness, quality and liking) and sem, for the mousse presented on rounded, squared, or triangular plates. Perceived intensity, sweetness and quality were rated on an unstructured 10-cm scale; Liking was rated on a 9-point Likert scale. * represents significant differences as measured with Tukey's honestly significant difference test, $p<.05$.

In addition, these attributes were also perceived as significantly different ($p<.05$) from one plate to the other, according to Tukey's test. For all the attributes, the sample on the white plate was scored higher than the sample presented on the black plate (M= 6.57 vs. 5.29, $p<.001$ for flavour intensity; M= 5.59 vs. 4.88, $p<.05$ for sweetness; and

M= 7.04 vs. 6.17, $p<.001$ for liking), as the interaction plot illustrates (see Figure 7.3a). In the case of the perceived quality of the samples, the difference between the ratings of the plates did not reach statistical significance (M=6.11 vs. 6.01, $p>.05$).

3.2. The effect of the shape of the plate

Contrary to expectations, the effect of plate shape did not reach significance in terms of participants' perception any of the attributes ($p>.05$) that were evaluated. This indicates that participants' perception of the strawberry mousse was unaffected by the shape of the plate on which it was served in the present study (see Figure 7.3b).

4. Discussion and conclusions

The present study investigated whether or not the colour (either black or white) and shape of the plate would exert a significant influence on the perceived flavour intensity, quality, sweetness, and liking of identical samples of strawberry mousse served from those plates. The results demonstrated that consumers' perception varied, as demonstrated by the significant differences in the mean scores. The colour of the plate exerted a significant effect on participants' perception of the majority of the attributes that were evaluated. A significant main effect of the colour of the plate on the perceived intensity of the flavour of the mousse sample was observed, with the mousse served on the white plate being rated 1.28 points higher on average (on a 9-point scale) than the sample served on the black plate.

It is possible that the colour of the mousse was perceived as being more intense when presented against the lighter, white background than against the darker, black background, as a result of a visual illusion, such as contour contrast (Hutchings, 1994). Thus, the mousse could have been perceived lighter in colour. In addition, border contrast could enhance this effect, by increasing the perceived colour difference between the darkness of the black plate and the lightness of the mousse. The phenomenon of simultaneous contrast (Ekroll *et al.*, 2004; Hutchings, 1994), could also explain the findings, since it results in a colour that is situated on another background colour taking on some of the hue of the complementarity of the background colour (i.e., a grey circle on a green background will seem to be pink).

There is evidence to suggest that the intensity of the colour of a food or drink item can impact on perceived flavour intensity (see Spence *et al.*, 2010). However, it is important to note that there are also many null results in the literature, and what is more, many of the results depended on the specific taste being evaluated, and all the factors that are in interplay, such as colour-taste congruency, and consumers' previous

experiences (Shankar *et al.*, 2010). In the case of the present study, the white background may have influenced the perceived pinkness of the mousse. This, in turn may have influenced the perceived sweetness of the dessert, and consequently participants' liking of the foodstuff. However, further research should be carried out in order to assess the validity of this suggestion.

By contrast, the angularity of the shapes of the plates did not affect the intensity of the flavour. This result might, though, be partially attributable to the fact that the triangular plates used were not especially angular (or pointy). Hence, it seems at least plausible that increasing the angularity of the plates might be expected to have a larger impact in people's perception of flavour intensity. Moreover, this effect might also be more evident in foods that are typically described as having a sharp taste, such as a sharp cheddar cheese, for example (see Gal, Wheeler, & Shiv, 2007). That is, sensation transference might be more common under conditions when the attributes of the plate correspond to the rated attributes of the food.

In summary, the findings of this study have provided evidence demonstrating a clear effect of the colour (or contrast) of the plate on flavour intensity, sweetness and liking of a sweet strawberry mousse. In the future it would be particularly interesting to further investigate the effects of other colours (or, more correctly, plates having different hues) and characteristics of the plates in order to discover possible ways in which to enhance the perception and experience of food, apart from modifying the ingredients of the food. What, for example, one might ask is the optimal colour with which to enhance sweetness or saltiness say, or does the result always depend on the colour of the food under consideration? In theory, one might wonder whether changing the colour of the plate (or packaging) could be used to enhance the perception of a certain taste or flavour, or as part of a strategy designed to reduce the amount of certain ingredients (e.g., sugar or salt), in a food or beverage, while keeping the flavour profile constant (Harrar, Piqueras-Fiszman, & Spence, 2011).

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8 Crossmodal correspondences between colour and flavour/ aroma

The influence of the colour of the cup on consumers' perception of a hot beverage

Piqueras-Fiszman, B. & Spence, C. (2012). The influence of the color of the cup on consumers' perception of a hot beverage. *Journal of Sensory Studies, 27,* 324-331.

Abstract

Research has demonstrated that the physical attributes of the containers from which we eat and drink can influence our perception of various foods and beverages and the overall consumption experience. In the present study, we extended this line of research in order to investigate whether the consumer's perception of a hot beverage (namely, hot chocolate) would be influenced by the colour of the plastic vending cup from which it was served. To this end, 57 participants tasted four samples of hot chocolate from four cups of the same size but different colour (red, orange, white, and dark-cream). The participants had to rate each sample of hot chocolate (two of which had been sweetened) on a number of sensory scales. The results revealed that orange (with a white interior) and dark-cream coloured cups enhanced the chocolate flavour of the drink and consequently improved people's acceptance of the beverage. By contrast, sweetness and chocolate aroma were less influenced by the colour of the cup, but still showed that the hot chocolate, when consumed from the dark-cream cup, was rated as sweeter and its aroma more intense.

Practical applications

The present results are relevant to sensory scientists interested in how the brain integrates visual input (such as colour), not only from the food itself, but also from the container, packaging, or plateware from which it is being consumed. In addition, these results should hopefully help stimulate chefs, restaurateurs, and those working in the food and beverage packaging sectors to think more carefully about the colour of their plateware/packaging and its potential effects on their customers' perception of the taste/flavour of the products that they happen to be serving/ delivering to market.

Keywords: Colour; consumer behaviour; sensation transference; crossmodal interactions; multisensory flavour perception; beverages

1. Introduction

The containers from which we eat and drink influence our perception of food and beverages and the overall consumption experience to a greater extent than most of us are consciously aware of (e.g., Lyman 1989; see Spence, Harrar, & Piqueras-Fiszman, 2012, for a recent review). Apart from functional reasons (e.g., the necessity of having a deep enough bowl to contain the soup that we happen to be eating, say), in many cases we prefer one container over the other, simply because the sensory attributes of the container somehow seem to enhance the consumption experience (see also Piqueras-Fiszman & Spence, 2011, for a similar example from the world of cutlery). An anecdotal example of this can be the favourite mug from which so many of us prefer to drink our tea or coffee. Perhaps that drink, which is always prepared in more or less the same manner, does not *really* taste better from our preferred mug, but the mug itself simply improves our overall multisensory experience.

Relevant here is research from Krishna & Morrin (2008). They demonstrated that participants rated water samples as being significantly lower in quality when they were allowed to touch or hold the flimsy plastic cup in which the water sample was served than when they were not. Such results highlight the impact that the haptic qualities of a container for drinking can exert on a consumer's quality appraisal and overall experience. In another recent study, this time reported by Schifferstein (2009), participants either had to evaluate empty cups made from different materials (all of them pinkish except for one which was transparent), or the experience of drinking hot tea or a chilled soft drink from these cups. For many of the attributes that were assessed, the results suggested that the drinking experience was related to the participants' experience of the cups. Interestingly, one of the attributes was sweetness: Specifically, the drinks consumed from the pinkish cups were rated as tasting significantly sweeter than when exactly the same drink was evaluated from a transparent cup instead. Such results suggest that Schifferstein's participants may unconsciously have transferred the experience of the pinkness of the cups (or rather, their intuitions about pink foodstuffs being sweet) to their judgments of the drinks themselves. Note that Cheskin (1957) long ago observed that adding 15% more yellow colour to the outside of a can of 7-Up resulted in consumers' becoming more aware of the lemony flavour of the drink. Meanwhile, Guéguen (2003) reported that people rated beverages served in blue-tinted glasses as significantly more thirst-quenching than when exactly the same drinks were presented in red, green, or yellow glasses instead. Such findings have recently been extended by other researchers

demonstrating that the colour of the plate or bowl can also influence a consumer's perception of the food (from popcorn to strawberry mousse; see Harrar, Piqueras-Fiszman, & Spence, 2011; Piqueras-Fiszman *et al.,* 2012; though see Yenket *et al.,* 2007, for a null effect of colour on the tactile perception of different fabrics).

However, in spite of the evidence concerning the effect of the colour of the cups or containers on people's perception of foods and beverages, there is only limited research to date, most of which has been conducted in the domain of wine (see Spence, 2011, for a review). This means that there are still a number of important questions that remain to be answered, such as, would a similar effect (of the colour of the container) be observed for hot beverages? It could be argued that something hot in the mouth is simply more attention-capturing (cf. Zampini & Spence, 2005), as there is a potential danger of burning/oral damage. As such, if the food itself (a hot beverage) is more demanding of a consumer's attention than a food served at room-temperature, it may be less likely that the colour of the container will impact on their perception. However, on the other hand, there are also reasons to believe that the effect of the colour of a vending cup (and perhaps specifically the colour of the inside of the cup) will have more of an impact than the colour of a plate, say, since one normally sees the inside surface of the cup up close when bringing the drink to one's lips. By contrast, the colour of the plate stays firmly affixed to the surface of the plate that normally does not move from the table, and hence is removed from the actual tasting experience.

In the domain of hot beverages, suggestive evidence comes from Favre and November (1979). They offered 200 people a single type of coffee in four different jars (brown, red, blue and yellow). 73% of the participants reported that the coffee served from the brown container was too strong, whereas 80% of women felt that the coffee served from the red receptacle had a richer, fuller aroma. The blue jar suggested to most a milder aroma and the coffee in the yellow container seemed to come from a weaker blend. The concept of sensation transference can be used to try and account for such effects (Spence & Piqueras-Fiszman, 2012); be it the "cold" from the colour of the cup or the "cheap" from the material properties of the cup (Spence & Piqueras-Fiszman, 2011). Each time, the attribute - be it sensory, emotional, or evaluative - appears to have been transferred from the cup to the consumer's evaluation of the drink itself (see Table 8.1 for a summary of findings published to date in this area).

Table 8.1. Summary of research that has investigated the effect of the receptacle of a drink/ food in the perception of the sensory characteristics of the drink/ food.

Author(s) (year)	Receptacle	Product	Characteristics studied	Main findings
Cheskin (1957)	Can	7-Up	Colour	Adding 15% more yellow to the outside of a green increased the perceived lemony flavour
Dichter (1964)	Packaging	Coffee	Colour	The majority of respondents associated the brown packet with a strong flavoured coffee, red with richness, blue with mildness/ smoothness & yellow with an excessively mild flavour.
Favre & November (1979)	Jars	Coffee	Colour	The coffee from the brown jar was rated as too strong, that from the red jar had a richer, fuller aroma, that from the blue jar a milder aroma, & that from the yellow jar appeared to have come from a weaker blend.
Guéguen (2003)	Cups	Soft drink	Colour	Drinks from 'colder-coloured' cups were judged as more thirst-quenching than those from warm colours.
Krishna & Morrin (2008)	Cups	Water	Flimsiness (touch - not touch)	Touching the flimsy cup decreased the perceived quality of the water.
Schifferstein (2009)	Cups	Soft drink and tea	Materials (and colour)	Drinks from cups were perceived similarly as those cups when empty.
Harrar *et al.* (2011)	Bowls	Popcorn	Colour	The sweet popcorn was perceived as saltier when eaten out of a coloured (as compared to a white) bowl, and vice versa for the salty popcorn.
Piqueras-Fiszman *et al.* (2012)	Plates	Sweet strawberry mousse	Colour (black & white)	When the mousse was served from a white plate, it was perceived as significantly more intense, sweeter, and. It was also liked more than when served from a black plate.

It is certainly true that many brands use specific colours in order to symbolize the cacao concentration, or the milk content (e.g., red tends to be associated with sweetness, purple with softness, yellow/white with milk, and black with a high concentration of cacao; see also Garber *et al.*, 2008; Wheatley, 1973). That said, the effect of these colours, present in packaging or on cups, on the flavour of the product has not been explored to date. Given the wide range of colours that are potentially available for disposable cups for hot drinks, such as chocolate, tea, or coffee, the aim of the present study was therefore to investigate whether the colour of plastic cups would influence the consumers' rating of the sweetness, bitterness, creaminess, flavour and aroma intensities, and/or liking of hot chocolate beverages.

2. Materials and methods

2.1. Participants

Fifty-seven volunteers took part in this study. The participants were attending a day-long sensory event, in which this tasting activity was included as a small part of the day's activities. No information about the specific aim of the study was provided to the participants prior to their activity. The volunteers ranged in age between 21 and 61 years (M= 25.4 years, SD= 8.8), and 31 were male. The procedures were explained to all participants in detail.

2.2. Stimuli

The stimuli consisted of plastic cups of the following colours: white, dark cream, reddish orange-and-white (with the outside orange and the interior white, though it will be referred as orange henceforth to simplify the description) and red, since those are the most common colours found among cups available for dispensed (or vended) hot beverages (see Figure 8.1). The different cups (different in terms of their inner colour) were used to explore whether the inner or outer colour would dominated in terms of any effects that could be observed. The cups were filled with 50ml of either a sweetened or unsweetened chocolate drink. The chocolate drink was prepared according to the specifications of the brewing system used, and insulated flasks were filled just prior to the experiment in order to maintain the drinks at the appropriate temperature. For the sweet condition, 50g of sugar was added per 1.5L of chocolate solution.

Figure 8.1. The four cups that were presented to the participants in the present study.

2.3. Procedure

Prior to the start of testing, the participants were given an information pack for the event, which included the relevant questionnaire for this study. The participants approached two tables in groups of 10-15, where 10-15 cups of each colour were laid out, each containing approximately 50ml of chocolate drink. The four stimulus samples were coded with a number for identification purposes. To avoid a possible sweetness-colour bias in the responses, the tasting procedure followed a complete blocked experimental design, as shown in Figure 8.2, in monadic sequence.

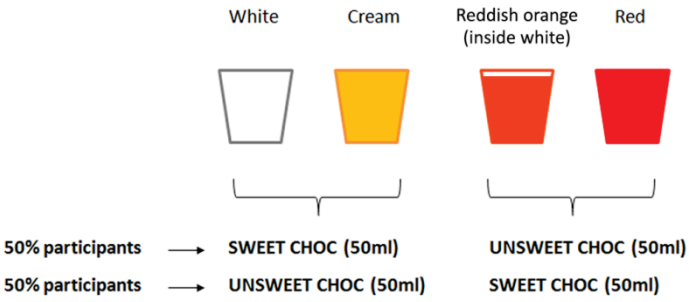

Figure 8.2. Diagram of the experimental procedure followed.

The instructions were given to participants at the start of the experiment, as follows: *"Please taste each of the drinks, in any order, and rate each one according to your own perception on the following scales"*. The questionnaire included these written instructions as well. 10cm-long scales were used to rate the drink samples in terms of their sweetness, bitterness, chocolate flavour, chocolate aroma, and creaminess (which were labelled at their anchors with "Extremely" and "Not at all"). To rate acceptability, the consumers had to score their overall liking using a 10 cm-labelled

affective magnitude scale (LAM; Schutz & Cardello, 2001). The LAM scale ranged from 'greatest imaginable dislike' to 'greatest imaginable like', and had incremental units of appropriate distances and labels as described by Cardello and Schutz (2004).

The participants were also instructed to rinse their mouth out with filtered natural water between tastings. Once a participant had finished tasting each sample, s/he was instructed to empty the leftovers into a basin, and deposit the cups in a recycling bin. Prior to the arrival of a group of participants at the testing table, new cups were prepared with chocolate drinks from four different flasks (2 pairs containing the same) previously stirred. Although the participants did not appear to be paying any attention to the serving process, this procedure was designed to avoid the 'curious' participant from gaining the impression that certain of the contents of the vending cups may have been the same.

2.4. Data analysis

A repeated measures analysis of variance (ANOVA) was performed on the data in order to determine the effect of the colour of the cup, if any, on the participants' perception of the various attributes that were being assessed. The colour of the cups and the type of drink, together with their interaction, and the participant effect were considered as explanatory variables. Significant differences were calculated using Tukey's test. Differences were considered significant when $p \leq .05$. All statistical analyses were performed using XLStat 2010 (Addinsoft, NY, USA).

3. Results

Liking. The colour of the cup exerted a significant impact on participants' liking of the hot beverage ($p < .01$). The fact that there was no interaction with drink type implies that the effect was similar for both the sweetened and unsweetened beverages (see Figure 8.3a). The chocolate drink served in the red cup was significantly more liked ($p < .01$) than when the hot beverage was served in the white cup (M= 4.6 vs. 3.3, respectively).

Chocolate flavour. The colour of the cup also exerted a significant effect on participants' ratings of the chocolate flavour of the hot beverage ($p < .05$). There was, however, no interaction with the type of drink. This means that the effect of cup colour was similar regardless of whether the participants were drinking the sweetened or unsweetened hot chocolate samples. The intensity of the chocolate flavour was rated as being significantly ($p < .05$) more intense when the hot beverage was served

from the orange cup than when it was served from the red cup and white cup (M= 5.4 vs. 4.6 and 4.6, respectively; see Figure 8.3b).

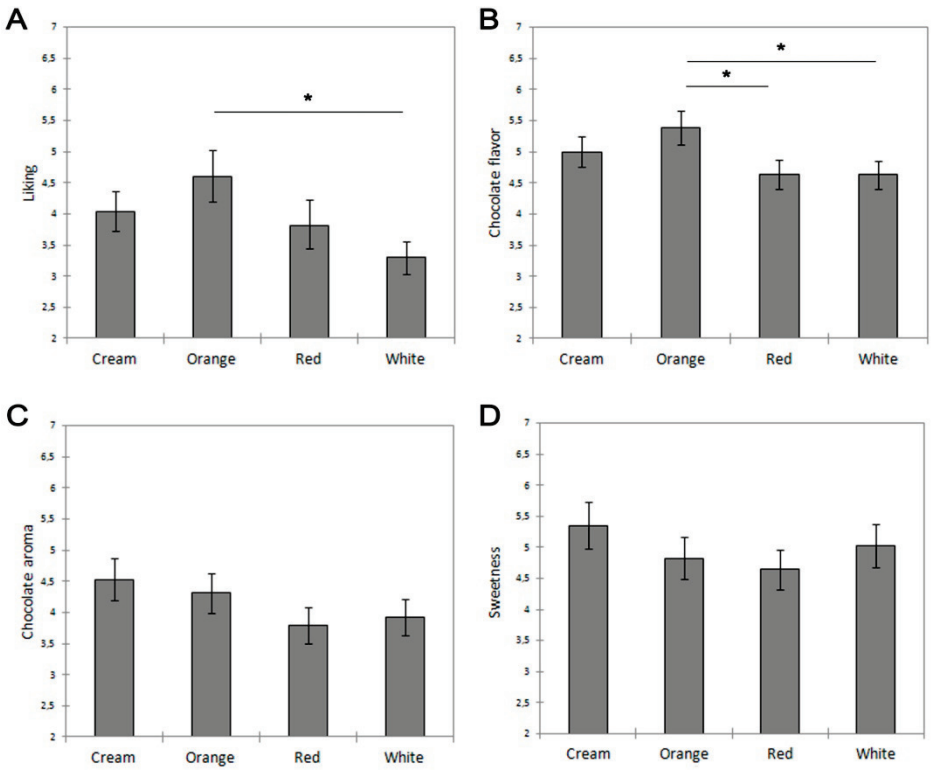

Figure 8.3. Mean ratings in a 10-cm scale, as a function of the colour of the cup and the type of drink. A) liking (on a LAMs); b) chocolate flavour; c) chocolate aroma; and d) sweetness. Error bars represent standard errors. *Tukey's significant differences at *p*< .05.

Chocolate aroma. As for the chocolate aroma ratings, the colour of the cup did not exert a significant effect on the perception of sweetness (*p*= .118), nor did its interaction with drink type. Nevertheless, it is still interesting to note that a similar pattern of results to those obtained for the sweetness perception was observed. The chocolate aroma from the cream-coloured cup was perceived as being more intense from the cream-coloured cup than from the red cups (at marginal levels, *p*= .07, M= 4.6 vs. 3.7; see Figure 8.3c).

Sweetness. The ANOVA revealed that the colour of the cup did not exert either a significant effect on participants' perception of the sweetness of the hot beverage (*p*= .176), nor did the colour of the cup interact with the type of drink that was being

tasted. However, when consumed from the dark-cream cup, the drinks were rated as tasting slightly sweeter, followed closely by the white cup, with the lowest sweetness ratings being observed when the hot chocolate was served from the cups that were red (Figure 8.3d). This subtle pattern was observed for both levels of sweetness (no interaction effects were observed).

No significant effects were found for either creaminess, or bitterness ratings, and hence these will not be discussed further here.

4. Discussion

Crossmodal associations between colours and tastes (and flavours), particularly the associations between redness and sweetness and greenness and sourness appear to be well-established (Clydesdale *et al.,* 1992; Johnson & Clydesdale, 1982; Maga, 1974; Roth *et al.,* 1988; Wei *et al.,* 2012; see Spence *et al.,* 2010, for a review). However, many of the crossmodal associations that we have internalized can perhaps be linked to the natural ripening process of certain fruits, and the simultaneous correlated change in taste (from sour to sweet) and colour (often from green to red; Maga, 1974). On the other hand, other colour-flavour associations we likely pick-up from the supermarket; e.g., see Garber *et al.,* 2008; Shankar *et al.,* 2010). However, even when any one of these colours is applied to non-fruit related products (e.g., to the packaging of a food product), consumers recall that learned association and tend to apply it (as in Schifferstein's, 2009, study; see also Cheskin, 1957; Garber, Hyatt, & Boya, 2008).

Of course, regarding chocolate, the darker the brown of the packaging, the higher the cocoa content ("stronger") we expect the product to be; and the lighter the brown, the higher the milk content or the creamier (cf. Duncker 1939; Tom *et al.,* 1987). Given these reasonably well-established associations, one might have thought that the chocolate drinks would be rated as tasting sweeter from the red cups, but instead, the cream-coloured cup rather than the red ones, enhanced the sweetness of the drinks. In fact, contrary to our expectations, the red-orange cups actually gave rise to the *lowest* sweetness ratings. Another unexpected result was that the cream-coloured cup did not enhance ratings of the creaminess of the hot beverage.

Where the orange cup (with the white interior) did give rise to higher ratings was in terms of the chocolate flavour and liking ratings, the dark-cream cup came a close second. Possible reasons for the variations between the ratings of the completely red cups and the completely white ones remain unclear. What is evident, though, is that the participants liked the contents more when consumed from the orange (with white

interior) cups and from the dark-cream ones than from the other two cups, with the white one being liked least. This latter result could perhaps be explained in terms of the fact that white cups are more common, hence the experience is not in any sense unusual.

A possible explanation for the observed results, that did not meet our expectations, is that despite the fact that certain colours are associated with specific sensory product characteristics due to the consumer's previous knowledge (i.e., redness being paired with sweetness), when it comes to consuming a product from another category (not fruit, but a hot chocolate beverage) from a coloured container, those associations do not necessarily hold true. Based on the results reported here, it might be the case that for chocolate drinks, a dark-cream coloured cup/ mug would enhance the perception of sweetness, while an orange one would intensify its flavour, consequently being more liked. Of course, one must also allow for the possibility that any effects of colour might be driven by a consumer's familiarity with a certain brand, should it be associated with a particular colour (cup), say. Relevant here is the fact that different vending companies tend to use different coloured cups/sachets for their chocolate range). Unfortunately, brown or black cups were not available in the same shape for possible evaluation in the present study; It would certainly be of interest to explore their influence on the perception of chocolate flavour/aroma in future research. That said, and with particular reference to the perception of hot chocolate beverages, it is worth noting that people rate chocolate products as tasting 'more chocolatey' when they are coloured brown rather than another colour (see Duncker, 1939; Shankar *et al.,* 2009; Tom *et al.,* 1987).

Would the same hold true if the colouring of the chocolate/coffee sachet were to be manipulated in a similar manner (cf. Garber *et al.*, 2008)? Only future research will tell. Of course, one needs to be careful here, given that while some colour associations stay constant over the years (not to mention decades), others may be much more short-lived, and change in accordance with changes in fashion and the marketplace (e.g., Downham & Collins 2000; Walford, 1980). Hence, it is important to be clear that the crossmodal colour conclusions drawn by researchers in previous years/decades need not necessarily hold true of today's marketplace. What is more, there are also likely to be a number of important cross-cultural variations that need to be borne in mind (e.g., see Jacobs *et al.,* 1991; Piqueras-Fiszman, Velasco, & Spence, 2012; Wheatley, 1973).

5. Conclusions

The results of the present study demonstrate for the first time that the colour of the cup can influence sensory-discriminative and hedonic (liking) evaluations of a familiar hot drink, namely hot chocolate. As such, these results back up previous results in this area that have demonstrated such effects with a variety of food and beverage items (see Table 8.1 for a summary of findings). However, now that such crossmodal effects of plateware/packaging colour on the sensory-discriminative and hedonic responses to the taste/flavour of food and beverage products have been robustly shown (i.e., demonstrated across a number of studies, by a number of labs, using a number of different foodstuffs), the more challenging theoretical question becomes one of explaining *why* such crossmodal effects occur. Furthermore, if, as seems increasingly likely, the effect of a given plate/bowl/cup colour depends, at least to some degree, on the particular foodstuff that happens to be under experimental consideration, then, one might wonder whether that constrains the explanation of the underlying crossmodal effect. It certainly means that any producer will probably need to do the coloured cup, plate, bowl experiment with their own product rather that necessarily relying on the results of prior research with other participants of another age-group. It would be interesting in future research to conduct a study in which multiple different food/drink products (e.g., having different colours) are served off of same range of containers in order to see how generalizable the effects are (and to more fully evaluate what role colour contrast may play in any effects observed).

In addition, the influence of the presence of certain colours on consumers' judgments of food or drinks is apparently not applicable to all cases, since, Beckman *et al.,* (1984) demonstrated, for instance, that colour as a means for product coding produced little or no bias when used in paired preference tests. Although theoretical explanations for the fact that the colour of the plate/bowl/cup can sometimes impact on taste/flavour perception have not been fully developed yet (see Spence *et al.*, 2012), the present results will nevertheless hopefully stimulate not only sensory scientists, but also innovative chefs and restaurateurs (and those working in the packaging sector) to think a little more carefully about the colour of their plateware / packaging and its potential effects on their consumers' perception of the taste/flavour of the dishes that they happen to be serving.

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9 A matter of weight: Sensation transference from haptic input to oral perception

Does the weight of the dish influence our perception of food?

Piqueras-Fiszman, B., Harrar, V., Alcaide-Marzal, J., & Spence, C. (2011). Does the weight of the dish influence our perception of food? *Food Quality and Preference, 22,* 753-756.

Abstract

In many categories, weight has been found to influence how users perceive and appraise products. However, to date, the influence of the weight of the dish in which food is served on people's perception has not been studied empirically. This exploratory study was therefore designed to investigate whether the weight of the container would exert a significant influence on people's sensory and hedonic responses to the food consumed from it. Three bowls, identical except for the fact that they were different weights, were filled with exactly the same yoghurt. Consumers evaluated the yoghurt samples from the three bowls holding them with one hand, one at a time. Participants rated flavour intensity, density, price expectation, and liking using 9-point Likert scales. Significant effects were found for all attributes except for flavour intensity. The effects on both density and price expectation ratings were highly significant.

These findings are potentially relevant for designers and those working in restaurants, the hospitality sector, and food production, since the design and choice of dishes (or packages) of various weights could potentially be used to help enhance and/ or modify the way in which consumers perceive and experience the food consumed from them.

Keywords: Food perception; weight; crossmodal correspondences; multisensory; sensation transference

1. Introduction

Design can be defined as a multidisciplinary process that requires the ability to materialize predefined intentions and expectations into new design solutions. Ideally, good design should improve the user's experience (Buchanan, 1989). From its many dimensions, designers can manipulate different variables, such as a product's sensory properties, in order to, for example, alter user behaviour and/or enhance product functionality.

From a multisensory perspective, many researchers have delved into how certain dimensions of experience are shared across the senses, or, in other words, the associations that most people make between diverse sensory attributes perceived via different modalities. These connections are commonly referred to as crossmodal correspondences (Schifferstein & Spence, 2008; Spence, 2011). The latest research findings demonstrate that crossmodal (or multisensory) interactions play a crucial role in our product perception and experience, and hence should be taken into account when designing products and their packages.

An extensive literature can now be found demonstrating the influence of one sensory design variable on how a product is perceived via another sense. To mention just a few recent examples: Becker, Van Rompay, Schifferstein, and Galetzka (2011) explored how the colour intensity and shape of a package influenced participants' ratings of the flavour intensity of yoghurts (at least for those participants who reported being sensitive to design); Zampini and Spence (2004) found that providing louder feedback, and/ or boosting just the high-frequency component of the sounds associated with consumers biting into crisps (or potato chips), resulted in their rating them as tasting significantly crispier. Spence, Shankar and Blumenthal (2011) have also shown a smaller, but nevertheless still significant effect resulting from varying the noise made by the rattling of noisy crisp packets. Elsewhere Demattè, Sanabria, Sugarman, and Spence (2006) have demonstrated that people rate fabric swatches as feeling softer when presented with a lemony or lavender odour than with an animal-like odour instead (see also Churchill, Meyners, Griffiths, & Bailey, 2009). Taken together, results such as these therefore clearly highlight the need for designers to consider the message that they wish to transmit, and to seek to find a congruent combination of sensory variables that is well interpreted and accepted by consumers.

In the food industry, crossmodal correspondences between the container and its contents are gaining ever-more relevance. For example, it has been shown that the

packaging or container attributes (e.g., the sounds it makes, its smell, feel, shape, and/or colour) will affect subsequent taste experiences and product appraisals, but not only due to physical interactions, but also as a result of crossmodal associations and/or perceptual illusions (see Cheskin, 1957; Gal, Wheeler, & Shiv, 2007; Hine, 1995; Schifferstein, 2009; Schifferstein & Spence, 2008; Spence & Gallace, 2011). Apart from packaging, containers such as cups and bottles have also been shown to modulate people's perception of the contents (e.g., Krishna & Morrin, 2007; Schifferstein, 2009). The size of the container has also been demonstrated to influence the amount of food that people consume (Wansink, van Ittersum, & Painter, 2006). However, the majority of studies published to date have focused primarily on the capacity or tactile properties of materials, such as their texture, rigidity, and temperature (e.g., Zampini, Mawhinney, & Spence, 2006). Meanwhile, other potentially equally important factors in product experience, such as product weight, have seemingly been ignored.

The weight of the object can transmit different meanings, and, according to Lindstrom (2005), in many product categories, there is a clear association between heaviness, quality, and expense, as, for example, in the case of perfume and wine bottles (Goldstein & Herschkowitsch, 2008, p. 80). In social behavioural research, Ackerman, Nocera, and Bargh (2010) have recently demonstrated that holding heavy or light clipboards non-consciously influenced participants' impression of job candidates they were evaluating. In their study, participants holding a heavy clipboard rated candidates' resumes as being better overall. In addition, there was also some suggestion that the weight of the clipboard affected participants' impressions of the candidates' traits related to a "heavy" metaphor. However, to date, there has been very little empirical research directly addressing the question of how a consumer's perception of the weight might affect their perception of food.

Thus, inspired by Ackerman *et al.*'s (2010) intriguing recent results, the aim of the present study was to investigate whether the weight of a food container, specifically a bowl being held in a participant's hand, would also influence their perception of the flavour and density, its expected price, and the acceptance of the food contained within.

2. Material and methods

The participants had to evaluate a sample of yoghurt, consumed while holding one of three bowls: a light bowl (L), a bowl with an intermediate weight (M), and a heavy bowl (H). The participants were not informed that the contents of the bowls were

identical in all three cases. The procedure followed a within-subjects experimental design. Each of the three conditions was coded with a random number for identification and presentation purposes.

2.1. Stimuli

The bowls used for the experiments were made of white ceramic (15.5cm in diameter, 375 grams) for the L condition. To avoid other sources of bias, the same bowl was used for the other conditions, but with a hidden weight attached (covering the entire base of the bowl). The bowl was 300 grams heavier in the M condition, and 600 grams heavier in the H condition. Pilot testing revealed that these weight differences were clearly perceptible to participants.

A hundred and fifty grams of natural Greek style yoghurt (Tesco, UK) were served in each bowl such that the three bowls appeared visually identical.

2.2. Participants

Fifty volunteers participated in the experiment. Participants were randomly recruited at the Department of Experimental Psychology (University of Oxford) and other public places, based on their interest in taking part in the study. At the recruitment stage, no information about the specific aim of the study was provided. All of the participants confirmed that they had no clinical history of major disease and that their senses of smell and taste were not impaired. The age of participants ranged between 20 and 69 years (M=32.9 years, SD=10.8), and 27 were female. Their Body Mass Index was not collected. The procedures were explained to all participants in detail and informed consent was obtained prior to participation.

2.3. Procedure

The instructions were given to participants at the start of the experiment. The experimenter placed one bowl at a time on a table situated in front of the participant, together with a metallic spoon. The three bowls were presented in random order in monadical sequence. That is, the previous bowl was taken away before the next bowl was presented. In each condition, the participants were instructed to hold the bowl with one hand and the spoon with the other (the one they usually used for writing). In addition, the participants were also instructed to hold each bowl in the same way during the course of the experiment. They could taste as much as one spoonful of yoghurt during each evaluation. The same type of stainless steel spoon was used for all participants. Filtered natural water and water crackers were available for rinsing between tastings.

For each condition, the participants were instructed to fill in four scales using a paper-and-pencil questionnaire after tasting a spoonful of the yoghurt. The questionnaire included written instructions as well, phrased: “Please pick up the bowl with one hand and try a spoonful. Rate the yoghurt according to your own perception”. Each scale had the attribute word to be rated situated on top. A 9-point Likert scale anchored with “not at all expensive” and “very expensive” were used to rate the yoghurt samples on expected price; for the perceived flavour intensity scale, the anchors were “not at all intense” and “very intense”. In order to rate perceived density, the scale was anchored with “very light” and “very heavy”. To rate acceptability, the consumers had to score their overall liking using a 9-point hedonic scale, anchored with “extremely dislike” and “extremely like”. Evaluations were performed under artificial daylight type illumination, temperature control (22-24ºC) and air circulation. After the complete evaluation and data collection from all the participants, they were debriefed as to the purpose of the study.

2.4. Data analysis

In order to determine whether the weight of the bowls exerted any significant influence over the perceived flavour intensity, density, price expectation, or overall liking scores, a non-parametric Friedman’s test was conducted on the data considering the weight of the bowl as source of variation. Differences were considered significant when $p<.05$. Effect sizes (Cramér's Phi, ϕ_c) were also calculated. These are expressed as the proportion of variance in the dependent variable (i.e., ratings of the attributes) explained by an independent variable (i.e., the three weight levels). When the effects were significant, post-hoc comparisons were carried out using Wilcoxon Signed-Rank Tests with a Bonferroni correction. Statistical analyses were performed using SPSS v.19.0 (IBM SPSS, Chicago, IL, USA).

3. Results

The results of the Friedman’s test revealed significant main effects of the weight of the bowls on perceived density ($\chi^2(2)=21.8$, $p<.001$), expected price ($\chi^2(2)=24.8$, $p<.001$), and liking ($\chi^2(2)=11.2$, $p=.004$) of the yoghurt samples, all of which increased as the weight of the bowl increased (see Figure 9.1). The perceived flavour intensity, by contrast, was not significantly affected by the weight of the bowls ($\chi^2(2)=4.5$, $p=.105$).

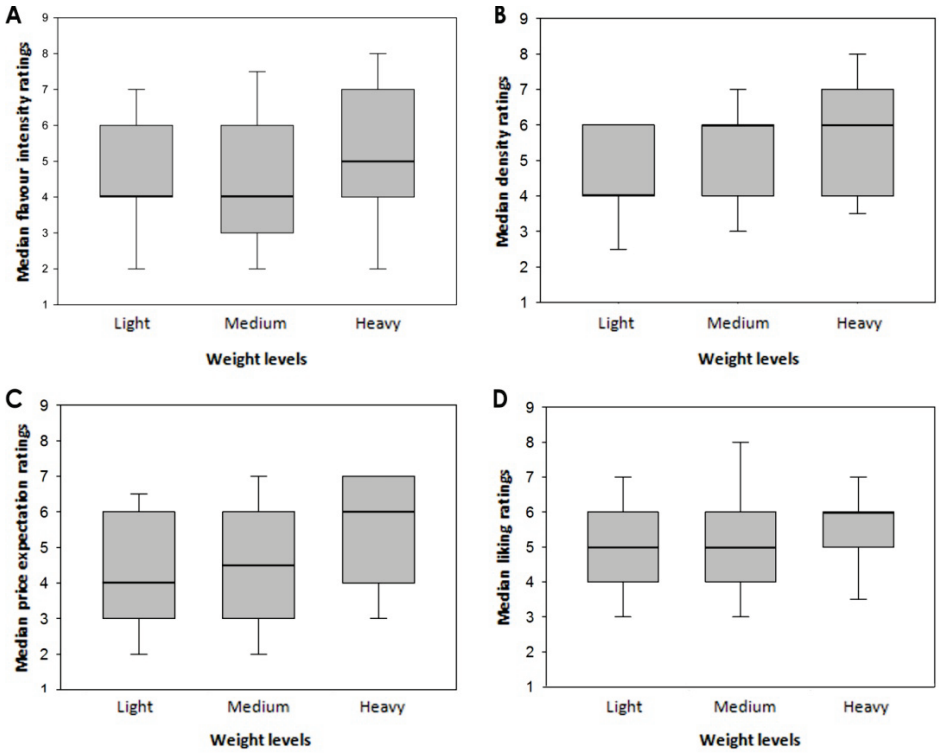

Figure 9.1. Median ratings (on a 9-point Likert scale) of the yoghurt samples as a function of the weight of the bowls for a) Flavour intensity; b) Density; c) Price expectation; and d) Liking. The boundary of the box closest to zero indicates the 25th percentile, the thicker line indicates the median rating, and the boundary of the box farthest from zero indicates the 75th percentile. Error bars indicate the 90th and 10th percentiles of the responses.

It is, however, relevant to highlight the fact that significant differences were not found between all the weight conditions for all four of the attributes assessed. To compare individual pairs, a Bonferroni correction for multiple comparisons was used, which set the significance level to $p<.017$ since there were three comparisons for each attribute (see Table 9.1).

Table 9.1. Median ratings for flavour intensity, density, price expectation, and liking.

Condition	Flavour intensity	Density	Price expectation	Liking
Light	4^{a}	4^{a}	4^{a}	5^{a}
Medium	4^{a}	6^{b}	4.5^{a}	5^{ab}
Heavy	5^{a}	6^{b}	6^{b}	6^{b}
Weight median	5	5***	5***	5*

Values with different superscripts within the same column for the same attribute are significantly different ($p<.017$) according to Wilcoxon Signed Ranks Test, with Bonferroni's correction. *Significant effect at $p<.01$.

Participants perceived the yoghurt sample from the lighter bowl as being significantly less dense than those taken from the medium bowl (Z=3.34, *p*=.001) and from the heavier bowl (Z=4.37, *p*<.001), while the sample from the medium bowl was not significantly different (Z=2.14, *p*=.033) from the yoghurt in the heavier bowl (see Figure 9.1b). Similarly, for price expectation ratings (Figure 9.1c), the samples from the lighter and medium weight bowls were very similar (Z<1) but both significantly differed from the sample in the heavy bowl (Z= 4.13, *p*<.001; Z=3.38, *p*=.001 respectively). In contrast, in the case of liking scores, participants discriminated the yoghurt sample from the lighter bowl as being significantly different from that in the heavier bowl (Z=2.53, *p*=.012) but not from the medium weight bowl (Z=2.25, *p*=.025). The samples from the heavy and medium bowls were similarly liked (Z<1; Figure 9.1d).

Larger effect sizes were observed for density and expected price (ϕ_c=.47 and .5, respectively). The effects for flavour intensity and liking were smaller (ϕ_c=.21 and .33, respectively).

Interestingly, no gender effects were observed in the ratings. This result indicates that men and women did not differ in their perception of the attributes being evaluated.

4. Discussion and conclusions

This exploratory study was designed to investigate whether the weight of the bowl constitutes an influential factor in terms of our perception and evaluation of food. The aim was to determine whether the weight of the dish held in a participant's hand exerted a significant impact on their perception of the food consumed from it. The initial hypothesis was that, as in many other product categories, the weight of a product might affect a person's appraisal of it. However, this idea had not been tested crossmodally, as in the present study. This particular crossmodal interaction was studied by modifying (adding weight) to two of three otherwise-identical bowls and having people rate identical yoghurts served from these three bowls one after the other. The results indicated that increasing the weight of the bowls had a greater impact on the perceived density (in mouth) of the same yoghurt sample served from them, and on the expected price, and to a lesser extent, on ratings of flavour intensity and liking, all of which increased in the heavier bowls.

These findings could well be relevant in terms of enhancing or modifying consumers' eating behaviours and experiences, in hospitality and restaurant settings. Furthermore, some of the participants spontaneously reported on perceived differences in taste (e.g., bitterness, sweetness) between the samples. However, such anecdotal

statements were not investigated further during the present study. Hence, how these sensory variables interact with external and independent variables such as the weight of the serving dish may represent an interesting direction for future experimental gastronomy research.

Interestingly, both of the attributes that were most affected by weight (perceived density and price) are related in society with weight properties: people commonly describe very dense foods as being "filling" or "heavy" and heavy perfume bottles as being expensive and/or of higher quality (see Spence & Gallace, 2011). Consequently, these results fit with Ackerman *et al.*'s (2010) findings. Namely, weight cues appear to exert a more pronounced effect on people's perception of attributes that are associated to "weight-related" metaphors.

A negative side-effect of the general associations that people make with density (in mouth) properties in this study is that the density results observed might to some extent reflect the participants' "filling" sensation or expectation, and not the real density of the sample. As demonstrated by Brunstrom and Wilkinson (2007) and Brunstrom, Rogers, Burn, Collingwood, Maynard, Brown and Sell (2010), energy density, expected satiation, and portion size all affect actual satiety.

An interesting area for future research would be to consider the participants' BMI and explore whether modifying the weight of the dish would differentially influence their expectations of satiety, or their sensation of being full.

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10 A matter of weight: Sensation transference from haptic input to expected satiety

The weight of the container influences expected satiety, perceived density, and subsequent expected fullness

Piqueras-Fiszman, B., & Spence, C. (2012). The weight of the container influences expected satiety, perceived density, and subsequent expected fullness. *Appetite, 58,* 559-562.

Abstract

We report a study designed to investigate the influence of the weight of the container on expected satiety prior to tasting the food within and on the perceived density of the food and any feelings of fullness expected to follow consumption (expected satiation). The results demonstrate that the contents of a heavier container are expected to be more satiating than when exactly the same contents are presented in a visually-identical, but physically lighter, container (even before the food has been tasted). In addition, we were able to validate a "weight-density" illusion, since the weight of the container was shown to influence the perceived density of the sample. Put simply, the heavier the container, the denser the food sample was perceived to be.

Keywords: Expected satiety; weight-density; expected satiation; container; food perception; sensation transference

1. Introduction

Over the last few years, a growing body of experimental research has focused on consumer perceptions and expectations of satiety in relation to food decision-making and consumption behaviours (e.g., Bilman, van Trijp, & Renes, 2010). Brunstrom and his colleagues have defined 'expected satiety' as the extent to which foods are expected to confer satiety. These authors have demonstrated that high fat foods and foods that are more energy-dense are expected to be less filling, calorie for calorie, than less energy-dense foods (Brunstrom, Shakeshaft, & Scott-Samuel, 2008). Such expectations are likely to be learned rather than based on the physical attributes of the food: A food is expected to deliver more satiety as it becomes more familiar (Brunstrom, Collingwood, & Rogers, 2010a; Brunstrom, Shakeshaft, & Alexander, 2010b; Wilkinson & Brunstrom, 2009) and once it has been eaten to fullness (Irvine, Brunstrom, & Rogers, 2008).

Any nutritional information that is provided can also play a role in modulating expected satiety. In an early study, Wooley (1972) demonstrated that presenting a food that was labelled as 'high calorie' reduced subsequent intake and increased feelings of fullness 20 minutes after the consumption of a meal. However, the effect of providing explicit information about the food on satiety is not always reliable (Yeomans, Lartamo, Procter, Lee, & Gray, 2001), since consumers might fail to trust a label, or the satiety effects might not last long after intake. In order to address this concern related to exposing participants to explicit satiety-related information, Brunstrom, Brown, Hinton, Rogers, and Fay (2011) recently demonstrated that manipulating people's beliefs about the amount of fruit in a fruit smoothie (by presenting either a large or small portion of fruit as the contents) influenced the expected and subsequent experienced satiety, at least three hours after consumption.

While it is now known that the actual (or perceived) portion size influences the consumers' expected satiety and actual food intake (Wansink & Van Ittersum, 2007), the characteristics of the container, tableware, and/or cutlery used also play an important role in our estimation of food/drink served and consumed (Mishra, Mishra, & Masters, 2011; Raghubir & Krishna, 1999; Wansink, Van Ittersum, & Painter, 2006). Illusions such as the vertical-horizontal (Wansink & Van Ittersum, 2003) and the Delboeuf illusion (which causes a given portion of food to be perceived as smaller against the backdrop of a large plate, as compared to that of a smaller plate; van Ittersum & Wansink, 2007), make it difficult for people to perceive and estimate this

amount/ volume correctly. Such perceptually-driven cues can, for instance, lead consumers to eat more or less depending on whether the plate or spoon is bigger or smaller, respectively, without them necessarily even being aware of it (see Smith & Ditschun, 2009, for a review).

In a recent psychophysical study, Piqueras-Fiszman, Harrar, Alcaide, and Spence (2011) demonstrated that yoghurt samples consumed from heavier bowls were rated by participants as more dense than identical samples consumed from lighter bowls. In addition, perceived quality and liking ratings also increased significantly as the weight of the bowl increased. These findings imply that modifying the weight of the container can have a significant impact on the perception of certain sensory and hedonic attributes of the product contained within. However, attributes related to the satiety of the food, which could have been influenced by the weight of the containers, were not assessed in that study. Given that the contents of the heavier bowl were perceived as being denser, it might be hypothesized that, due to a possible "weight-density" illusion, consumers would have expected the contents of the heavier bowl to be more satiating as well (Hogenkamp, Stafleu, Mars, Brunstrom, & de Graaf, 2011), hence possibly affecting their subsequent satiety. Another hypothesis is that the yoghurt could be expected to be more satiating, perhaps merely as a result of the perceived weight of the bowl in the participant's hand/s, independent of the perceived density of the sample, due to the phenomenon of "sensation transference" (see Cheskin, 1957; Spence & Piqueras-Fiszman, in press).

In this context, we wanted to extend our previous research by exploring whether the weight of the container would influence the satiety-inducing aspects of the food contained within. Therefore the main aims of the present study were: 1) To investigate whether expected satiety could be manipulated by modifying the weight of the container in which a food is served (without tasting it); 2) To test whether food containers of different weights affect the perceived density of the food within, verifying previous results (Piqueras-Fiszman & Spence, 2011); and 3) To explore any relationships between the perceived density of the food and expected satiation (fullness).

2. Materials and methods

2.1. Participants

Forty-five participants (22 female; mean age=29.8 years, SD=2.5; BMI: 23 kg/m^2, SD= 2.6) took part in the study. The participants were randomly recruited at public places

in Valencia (Spain), based on their interest in taking part in the study. At the recruitment stage, no information about the specific aims of the study was provided. All of the participants confirmed that they had no cold or flu, that their senses of smell and taste were not impaired, and that they did not suffer from any allergies to dairy products (they had to be regular consumers of yoghurts). The participants had to evaluate a sample of yoghurt, consumed in one of two conditions at a time: while holding either a 'light', or a 'heavy' bowl. The participants were not informed that the contents of the bowls were identical in both cases; they were told that they were trying a new recipe and to respond to the questions as sincerely as possible. The procedures were explained to all participants in detail and informed consent was obtained prior to participation. The experiment was conducted in accordance with the ethical regulations set down in the Declaration of Helsinki (2008) and lasted for approximately 10 minutes.

2.1. Stimuli

125 g of commercially available strawberry yoghurts (Danone Vitalinea® Cremoso; Barcelona, Spain) were served in plastic white bowls (20 g; 90 mm diameter). For the 'heavier' condition, a hidden 75 g lead weight was attached to the base of the bowls (covering the entire base), thus the bowls in the two conditions were visually identical. The volume of the samples was intended to be the same visually, given Brunstrom *et al.*'s (2010a) demonstration that the perceived volume of food plays an important role in judgments of expected satiation. The added weight was selected in pilot testing to make the difference in weight just perceivable (and hence not striking), and to simulate the possible weight of a thicker product (with the same volume). The sample in each condition was coded with a random number for identification and presentation purposes.

2.2. Procedure

The procedure followed a within-participants experimental design. In order to directly evaluate the effects of the weight manipulation, we measured the expected satiety of the two bowls of yoghurt using a variation of the 'method of adjustment', described by Brunstrom *et al.,* (2008; see also Brunstrom & Rogers, 2009). In this version, the participants were given either of the bowls in one hand. They were instructed to hold it as they would normally hold a bowl of yoghurt. The order of presentation of the two bowls was balanced, that is, half of the participants were given the 'heavy' bowl first, while the other half were given the 'light' bowl first. Next, they were shown four

colour images of familiar foods (cooked pasta, 145 g; salted crackers, 50 g; peanut butter cookies, 39 g; and grapes, 290 g), one at a time in random order for each participant, in a size as similar to reality as possible. All these food portions contained 200kcal and were presented on the same plate (white, 26cm of diameter); the name of the food was also presented in a corner of the images; see Figure 10.1). Holding either bowl in one hand, the participants had to indicate the portion of food shown on the screen they would consume so that it would stave off hunger to the same extent as consuming the bowl of yoghurt that they were holding in their hand. The task was phrased as follows: *"Please indicate the amount of food in the picture that would deliver the same satiety as consuming the dairy food you are holding"*. They were asked to indicate this portion in percentages or fractions.

Figure 10.1. The pasta dish image shown to participants for the comparison task.

After doing this, the screen was switched off and the participants were once again given one of the bowls, in a balanced order across participants. They consumed a single spoonful of yoghurt from each bowl, and rated its perceived density on a 10-cm visual analogue scale (VAS) anchored with 'not at all' and 'extremely'. Density was explained by the experimenter as being a sensory characteristic similar to thickness. In addition, after rating the samples from the two bowls, the participants were asked to indicate which of the two yoghurts they expected would make them feel fuller; they could also indicate "both equally".

At the end of the experiment, the participants completed a questionnaire, in which age, sex, body weight, and height were reported. In addition, they were also asked to rate on an unstructured 10-cm scale whether they actively restricted their intake of food, anchored with 'never, I eat as much as I like' and 'I always control the amount of food I eat'. Then they were debriefed and thanked for their participation.

2.3. Data analysis

The participants' ratings of their expected satiety, expressed as fractions or percentages, were transformed to arc-sine values before being analysed to improve normality. Four paired t-tests were performed on the normalized expected satiety data, for each of the four comparison foods. To study whether the weight of the bowl influenced the perceived density of the sample, a paired samples t-test was performed on the density ratings. In addition, to check whether the perceived density of the contents of the two bowls was related to the choice of which one they would expect to keep them fuller (that is, to be more satiating), an ANOVA was performed considering the choice (either light, heavy, or both) as the source of variation.

In addition, participants' characteristics (sex, BMI, and their intake restriction rating) were also included in separate ANOVAs to investigate any possible relation between these with the perceived density and expected satiety.

Results were considered statistically significant at p-values <.05. Statistical analyses were performed using XLStat 2010 (Addinsoft, NY, USA).

3. Results

Expected satiety differed significantly between the two containers (p<.001). The yoghurt served from the lighter container (L) was expected to be less satiating than the yoghurt served from the heavier container (H), across all of the comparison foods shown (see Figure 10.2). The participants indicated they would eat significantly more pasta (p<.01), salted crackers (p<.001), peanut butter cookies (p<.05), and grapes (p<.05) when they were holding the heavier yoghurt container. In addition, gender effects were observed between the expected satiety ratings. Male participants said that they would eat more than female participants to keep them as full as what they were holding; in particular, significantly more crackers (p<.05) and cookies (p<.05).

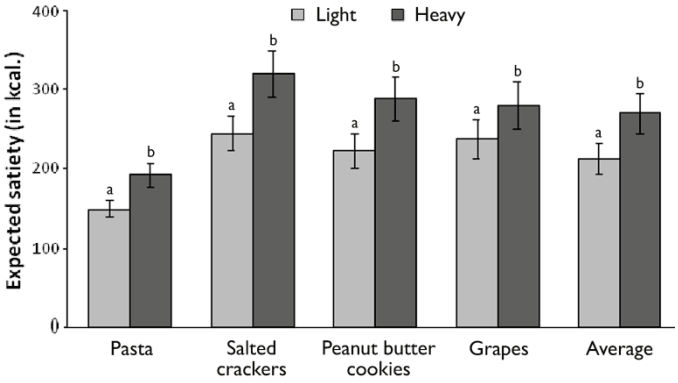

Figure 10.2. Mean expected satiety scores (in kcal) obtained with the version of the "method of adjustment" with the comparison foods. Error bars represent SEM. Columns with different letters differ significantly ($p<.05$).

The weight of the container also influenced the perceived density of the sample. On average, yoghurt sample L was perceived as being significantly less dense ($p<.05$) than sample H (M= 3.62 vs. 4.64, respectively, see Figure 10.3). Additionally, the majority of the participants (32 out of 45) expected sample H to make them feel fuller, whereas only 10 people chose sample L. Those who chose sample H, differed significantly between the perceived density of the two samples, rating sample H as significantly denser than sample L (M= 4.36 vs. 3.11, $p<.05$). By contrast, the difference in perceived density did not reach significance (M= 5.32 vs. 4.86, $p=.82$) for those who chose sample L.

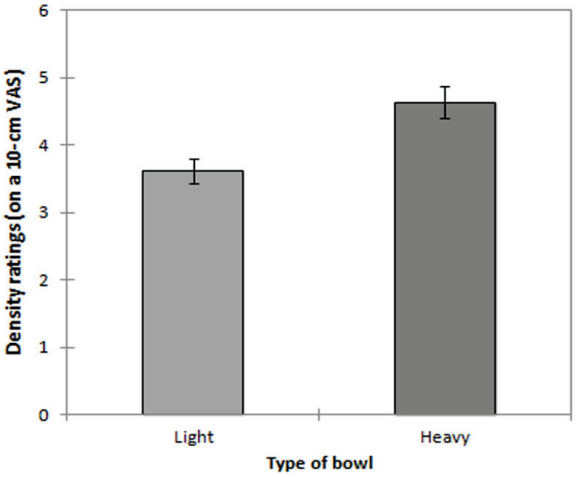

Figure 10.3. Mean density ratings for each type of bowl. Error bars represent Tukey's honestly significant differences at $p<.05$.

No other effects were observed in the density ratings. This result indicates that the differences in weight of the containers affected the participants' perception of density and expected satiety after trying a spoonful of the two yoghurt samples in a similar manner.

4. Discussion and conclusions

The present study was designed to investigate any influence that the weight of containers might have, first on expected satiety without tasting the food contained within, and second, on the perception of density of the food and on the satiation expected to follow consumption. The results demonstrate that modifying the weight of the container can alter expected satiety, even before a food has been tasted. By asking participants to indicate the portion of different foods that would be equivalent to consuming the bowl of yoghurt they were holding in their hands, we were able to corroborate the claim that the contents of a heavier container are actually expected to be more satiating than when exactly the same contents are presented in a visually-identical, but physically lighter, container. Hence our hypothesis was confirmed. One psychological mechanism that might underlie such effects could be "sensation transference" (Cheskin, 1957; Spence & Piqueras-Fiszman, in press). As mentioned earlier, sensation transference refers to the notion that a consumer's feelings about the packaging/ plateware may transfer over to influence their ratings of the contents. This form of what is sometimes called 'affective sensory ventriloquism' (see Spence & Gallace, 2011) has also been observed across a range of studies which demonstrate that we unconsciously relate and transfer crossmodally certain attributes of a product (e.g., the colour saturation of a packaging label, or in this case the weight) to our perception of other qualities that the product within either may, or may not, actually present (in this case its density and expected satiety and satiation; see Hine, 1995, for further examples).

In addition, these results demonstrate that the adaptation of the 'method of adjustment' used in this study provides an appropriate means of assessing expected satiety, even if the participants themselves had to estimate the portion of a foodstuff represented in an image that they would consume.

These results also corroborate previous findings highlighting the impact that the weight of the container has on the perceived density of a sample of food (Piqueras-Fiszman *et al.*, 2011). The heavier the container, the denser the food was perceived to be ($p<.05$). As suggested earlier, this effect could be considered as a "weight-density"

illusion. However, it is worth remembering that, in the present study, the weight of the two containers differed by only 75 grams, and that the containers were more similar to those used as actual yoghurt packaging. Hence this makes the results observed here more ecologically valid for applications such as packaging or disposable catering supplies than those of previous studies (i.e., Piqueras-Fiszman *et al.*, 2011, where the variation in the weight of the bowls was much larger – 300 grams).

When it comes to the results concerning expected satiation observed after the participants had actually tasted a spoonful of yoghurt from each of the bowls, it would appear that the weight of the bowl profoundly influenced participants' responses. The results demonstrate that the majority of participants indicated that they expected the yoghurt sample H to be more filling, and perceived it as being significantly denser. These results are consistent with Hogenkamp *et al.*'s (2011) recent findings. They demonstrated that the thickness of dairy products is positively correlated with expected satiation ($p<.001$). However, in the present study, those participants (22%) who expected sample L to be more filling still perceived it, on average, as being slightly less dense. Therefore, for this minority of participants, weight impacted on the perceived density, but not on the choice of which one they expected to be more satiating. The result observed for this small group of participants might be explained by the fact that the difference in perceived density was so subtle that it made them chose, in a rather arbitrary manner, the sample which they would expect to make them feel fuller.

Overall, these results demonstrate that a very modest modification in the weight of the container in which a food is contained (75 g) can significantly alter the expected satiety of the consumer holding the product.[4] As mentioned earlier, previous studies have already demonstrated that expected satiety can be influenced by many factors (e.g., the perceived volume of the food, the portion size of food intake, or the information provided about the energy density or the contents). However, the weight of the dish or container has not been studied in any depth before, and it might also

[4] In an as yet unpublished pilot study, we carried out the same experiment in the UK with real yoghurt containers (pots) and two varieties of yoghurt: toffee and vanilla flavoured (having the same density but one darker in appearance than the other). The vanilla flavoured yoghurt containers were modified to be perceptibly heavier. The results revealed that the vanilla yoghurt was expected to be more satiating (as a result of holding the pot), and perceived density ratings were also higher. However, it remains to be explored whether these results were biased by the flavour of the sample and/or its visual appearance (i.e., color). That said, it has been shown that flavour does not influence the expected satiation of dairy products (Hogenkamp *et al.*, 2011).

have an effect on the portion of food served (and perhaps consequently on the intake of food), since apparently it might give to the illusion that one is "carrying" more (dense) food. It would be interesting in this regard, for example, to study whether varying the weight of the serving tray in a canteen would impact how much food people decide to put on it. Certainly, these findings could be applied to the design of food products (packaging or tableware) that are intended to deliver satiety, reduce meal size, and possibly also aid weight loss.

Nevertheless, that said, it is worth remembering that our study involved a within-subjects experimental design, hence possibly setting-up a contrast effect that might not be present in everyday 'normal' situations, given that not everybody necessarily lifts up two products from the shelf, say, to compare them. It would therefore be very interesting in future research to explore whether the effects of the weight of the container on the perception of the contents are also observable in a between-subjects experimental design. Another limitation is the fact that, although the task was somewhat disguised, one can never completely rule out the possibility that certain of the participants may have intuited the actual purpose of the study; hence some assessment of their awareness might have been provided us with this valuable information. In addition, further research will need to be carried out in order to test whether the weight of the container does have an impact on actual satiety (Brustrom *et al.,* 2010c), and how long the effect lasts (i.e., does it extend over several consumption episodes; see Fay, Hinton, Rogers, & Brunstrom, 2011). In addition, it would be convenient to validate these results in a more realistic context and setting.

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11 Sensation transference of abstract attributes: Quality

Do the material properties of cutlery affect the perception of the food you eat? An exploratory study

Piqueras-Fiszman, B. & Spence, C. (2011). Do the material properties of cutlery affect the perception of the food you eat? An exploratory study. *Journal of Sensory Studies, 26,* 258-262.

Abstract

Our perception of food depends both on the contextual conditions in which it is presented and on the way the food is consumed, hence the current trend toward investigating these contextual variables in empirical research. In most meal situations, people interact with the food that they consume by means of a variety of accessories, such as dishes and cutlery, which fulfil the consumers' functional requirements. However, despite the important role that these accessory stimuli play during the consumption of food, little research has been carried out in order to investigate how they may affect food perception. The present preliminary study was therefore undertaken in order to explore how the cutlery, specifically two teaspoons (a plastic one with metallic finish, and another stainless steel one), affected consumers' sensory and hedonic perception of yoghurt. Consumers' quality and liking judgments concerning identical yoghurt samples differed significantly when tasted either with a metallic plastic spoon or else with a stainless steel spoon, the latter resulting in significantly higher scores.

Practical applications

These results contribute to our knowledge of how contextual variables affect a consumer's perception of food. These findings open up new research directions emphasizing the potential importance of the properties of cutlery and its influence on consumers' perception of food. These results are relevant to product development, and to caterers and restaurateurs, since different dishes (i.e., foodstuffs/ flavours) could be matched with different types of cutlery in order to increase convenience and, at the same, time potentially enhance the consumers' eating experience.

Keywords: Cutlery; multisensory food perception; materials; consumers; context; material properties; sensation transference

1. Introduction

During consumption, many different factors affect, either directly or indirectly, how consumers interact with, and consequently perceive, food. Apart from the physical properties of the food itself, contextual variables also play an important role. Several studies have contributed to furthering our understanding of how factors such as the company, the presentation of the meal on the plate, and/or the portion size, can affect people's rating of the acceptability of foodstuffs (e.g., King *et al.,* 2004, 2007; Reisfelt *et al.,* 2009; Schifferstein, 2010; Wansink & van Ittersum, 2003, 2007; Wansink, van Ittersum, & Painter, 2006). In a direct way, and in most developed regions, people interact with a variety of utensils, some of which are used to serve the food or drink they are going to consume, and others to move the food from plate to mouth. The wide variety of different utensils available nowadays serves not only to meet the functional needs of consumers, but also to transmit certain feelings to the user, not to mention fitting into different usage contexts. In many contexts, the physical food is just one of several elements that help to construct the intended consumer experience (Schifferstein, 2010). However, little of the research on the perception of food has yet placed much emphasis on the accessories, implements, or tools, that people use when eating (at least when eating in polite company). Schifferstein (2009) conducted one of the few studies in this area. He explored the effect of cups' properties on the experience of drinking beverages, reporting that for some attributes, the drinking experience seemed to depend on the type of cup used. In an attempt to further explore this important area of research, the present study focused on one of the most commonly-used pieces of cutlery that people in the West use, namely the teaspoon.

Cutlery is manufactured out of various materials, and formed into various shapes, and sizes. The decision to choose one type over another is conditioned by the intended context of use. For example, people would not expect to find plastic cutlery in a formal restaurant, nor to find fine sterling silver cutlery in a fast food joint. Similarly, many airlines would prefer to use light metallic type of cutlery on board (ideally constructed from something like titanium, for its lightness) rather than heavy metallic cutlery. However, among the spectrum of possible options offered by different material properties, shapes, and sizes, experiential factors should perhaps also be taken into account in order to aid in the selection of the most appropriate cutlery.

Cutlery has been in common usage by all strata of society in Europe since the 19th Century (e.g., see Brown, 2001; Elias, 2005; Himsworth, 1953; Visser, 1991), and the

notion of a silver spoon (together with its associations with high class and moneyed) has made its way into our everyday life (as the Silver Spoon brand of sugar; Aldersey-Williams, 2011). To date, however (at least to the best of our knowledge), little research has been conducted in order to investigate whether the material properties of the cutlery influence multisensory flavour perception, experience, and acceptability ratings for foods.

That said, researchers have recently started to conduct research investigating the taste that different metals have (Laughlin *et al.,* 2009, 2011; Miodownik, 2008). The results available to date would seem to suggest that stainless steel spoons electroplated with different metals taste slightly different (though note that the participants in these studies were asked to rate the taste of the spoons themselves, rather than anything, i.e., a food, placed on them). So, for example, those spoons plated with copper and zinc were rated as tasting more bitter and salty. However, as yet, no studies have reported whether any taste the cutlery has can be transferred, and thus affect, the perceived taste or flavour of the food contained thereon.

The weight that objects possess conveys different meanings to the people who interact with them. According to sensory marketers, such as Martin Lindstrom (2005), there is a clear association between weight (or rather perceived heaviness), quality, and expense in many product categories, as in the case of perfume and wine bottles (see also Goldstein & Herschkowitsch, 2010, p. 80; Spence & Piqueras-Fiszman, 2012). Meanwhile, the latest social behavioural research has demonstrated that heavy or light clipboards non-consciously influence the impression that people holding those clipboards form concerning the job candidates that they happen to be evaluating (Ackerman *et al.,* 2010). In particular, participants holding a heavy clipboard rated candidates' resumes as better overall. In addition, the weight cue also appeared to affect people's impressions of the candidates' traits related to a "heavy" metaphor. However, the question of how product experience is modified by weight perception has not been studied in depth previously in a food setting.

Ariely (2008; pp. 159-160) reported that changing the containers in which the paraphernalia that often goes with coffee (e.g., the sugar bowl, the milk flask or jug, the cinnamon and chocolate shakers, etc) exerted a significant influence on people's liking for coffee. In this study, participants were offered a free cup of coffee in return for answering a few questions such as how much they liked the coffee and the maximum price they would be willing to pay for it. At certain times, the containers

were made of glass-and-metal, set on a crushed metal tray and accompanied by silver spoons and nice labels. At other times, the very same condiments were placed in Styrofoam cups with the labels written on in felt-tip pen instead. Ariely reported that when the condiments were presented in higher quality containers, people were much more likely to say that they liked the coffee a lot, and that they would pay more for it. They were also more likely to suggest that that coffee should be regularly served in the cafeteria. As Ariely puts it: *"When the coffee ambience looked upscale, the coffee tasted upscale as well"*.

Based on the literature reviewed here, one might reasonably ask whether cutlery having different material qualities would also affect the perceived quality or taste of the food consumed from it. Would the food consumed from a metallic spoon, for instance, be perceived as being of higher quality than that consumed from a plastic one? The preliminary exploratory study reported here looked for evidence that the material properties of the cutlery, namely teaspoons, exert some influence on the gustatory, hedonic and quality perception of a food tasted (namely yoghurt) with those spoons.

2. Materials and methods

2.1. Stimuli

Two hundred grams of vanilla yoghurt (Rachel's Organic, UK) were placed at 10ºC in two small glass bowls.

The two types of spoons used to carry out the experiment consisted of a stainless steel (SS) spoon (19.2g; 3.3*15cm), and a plastic spoon with a polished metallic finish (4.9g; 3.3*15.5cm). Metallic-plastic was preferred over common (generic) plastic spoons in order to avoid introducing any additional differences in the spoons' appearance properties, in fact, visually, it was not possible to distinguish the metallic from the plastic spoon (see Figure 11.1). As Miodownik (2008) notes *"polish and glitter are an important part of the senso-aesthetic experience of eating: We eat with our eyes as well as our mouths"*.

Figure 11.1. Picture of the two types of spoons used in the present study. On the left, the stainless steel spoon; on the right, the metallic-plastic spoon.

2.2. Participants

Fifty volunteers participated in the experiment. Participants were randomly recruited at a social event held in London, UK. At the recruitment stage, no information about the specific aim of the study was provided. The age of the participants ranged between 23 and 68 years old, and 28 were male.

2.3. Procedure

The instructions were explained to all participants prior to the start of the study. The participants evaluated the same vanilla yoghurt presented in the two bowls coded with three-digit codes, tasting it with both the SS spoon and the plastic spoon, situated beside each bowl, one at a time. Importantly, the participants were not informed that the contents of the two bowls were actually identical. After tasting each sample, in an approximately counterbalanced order, the participants completed three response scales on paper ballots, identifying each sample with the code. The participants used 10-cm line scales printed onto A4 sheets of paper in order to rate the perceived quality and flavour intensity of the yoghurt, anchored with “nil” and “high”. They also had to rate their overall liking using a 9-point hedonic scale anchored with “extremely dislike” and “extremely like”.

2.4. Data analysis

In order to determine whether the properties of the spoons exerted a significant influence on the perceived flavour intensity, quality, and overall liking scores, an analysis of variance (ANOVA) was performed on the data considering these factors as independent variables and the type of spoon as a fixed source of variation. When the effects were significant, honestly significant differences were calculated using t-tests. Differences were considered significant when $p \leq .05$. Statistical analyses were performed using XLStat 2010 (Addinsoft, NY, USA).

3. Results

The results are shown in Figure 11. 2. Significant differences were found in the ratings of the sample when tasted with the two spoons.

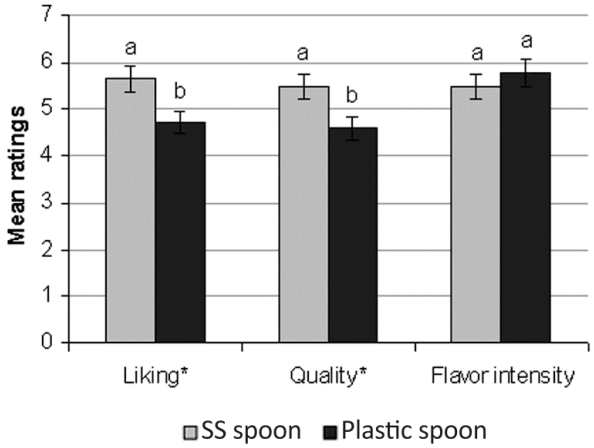

Figure 11.2. Participants' mean rating scores (liking evaluated on a 9-point hedonic scale, flavour intensity, and quality on unstructured 10cm line scales). Vertical bars represent significant differences, means with different letters are significantly different ($p<.05$). *Significant effect at $p<.01$.

The type of spoon used to evaluate the yoghurt exerted a significant influence on people's perception of the quality of the yoghurt ($F=12.41$, $p=.01$), where the mean score for the SS spoon (M=5.5) was significantly higher ($p<.01$) than for the plastic spoon (M=4.6) on an unstructured 10cm line scale. Significant effects were also found for the overall liking scores ($F=8.31$, $p=.005$). Similarly, the sample tasted with the SS spoon (M=5.6) was rated significantly higher ($p<.01$) than with the plastic spoon (M=4.7). However, there was no significant difference between the scores for flavour intensity, where the mean scores for the sample tasted with plastic and SS spoons

were 5.8 and 5.5, respectively (on the 10cm unstructured scale). Surprisingly, when other variables were analysed for possible effects, gender was found to exert a significant influence ($p<.05$) on perceived flavour intensity. Overall, the females scored the yoghurt sample higher (M=6.2) than did the male participants (M=5.2), regardless of the spoon they tasted the sample with. No other variables showed significant differences on any of the other attributes evaluated.

4. Discussion and conclusions

This study constitutes a first attempt to investigate the effect that cutlery has on our perception of food. By giving participants identical yoghurt samples to taste with two different spoons, we were able to test whether their material qualities would affect the participants' gustatory, hedonic, and quality perception of the yoghurt. The significant effects observed for quality perception and liking could be taken to support Lindstrom's (2005) statement about the associations between heaviness and quality in some product categories (see also Spence & Piqueras-Fiszman, 2012). However, the findings of this study also suggest that that sense of higher quality that the stainless steel spoon might have in consumers' minds, in comparison to the metallic-plastic spoon, could be transmitted to the food (one can even think of this in terms of Cheskin's, 1957, notion of sensation transference); thus resulting in them perceiving it as of higher quality and consequently affecting positively their hedonic judgments.

The conclusions based on the results of the present study are consistent with the anecdotal findings reported previously by Ariely (2008) and Schifferstein (2009). As Schifferstein demonstrated, for some (mostly abstract) attributes the experience of the empty cup was directly transferred to the experience of drinking from those cups (i.e. if the empty cup was itself rated as interesting, so too was the experience of drinking from it). In addition, in his study, the sweetness (a sensory attribute) of the beverages was rated significantly higher when they were consumed from cups that were pinkish than from a transparent cup, suggesting that the 'sweetness' induced by the pinkness of the cups might have influence the participants' judgments of the sweetness of the drink within.

As limitations in the present study, the two spoons considered, in spite of having quite similar physical appearance (size, shape of the bowl, and surface; see Figure 11.1), were not identical (in the style of the handle's end), which might have influenced the results to some extent. In addition, they varied in many intrinsic material parameters, such as the temperature and the weight. Therefore, the results obtained here could, in

principal, be explained by the combination of theories that relate weight with quality perception and quality appraisal transference. However, the results could also be exclusively a matter of weight (e.g., in line with Ackerman *et al.*'s, 2010, conclusions). Here it is worth highlighting the fact that a product's weight can also impact how the user experiences the product independently from the value conveyed by the material (note here that the stainless steel spoon was both perceived as being of higher quality and weighed more). To illustrate this point, it has been reported that the fine lightweight titanium cutlery set that was designed especially for Concorde (when it was still flying) was so light that people simply did not like eating with them when they were trialled. This, despite the obvious high quality perceived in the designer cutlery set.

In the future, it will be desirable to conduct more controlled experiments in order to determine the exact parameters that influenced the differences found in the quality perception of the food sample, and to gain a better understanding of their relative effects on the different components of food perception (here, only the two most common types of materials found in Western countries' cutlery- metal and plastic- were used). Nevertheless, that said, the results reported here clearly provide preliminary evidence to demonstrate just how profound an effect a simple change in the material of a teaspoon can have on our perception of the food we eat with that piece of cutlery.

It is also relevant here to highlight the fact that the associations between certain materials and the concept of 'quality' may well vary somewhat across cultures. Thus, it cannot necessarily be assumed that metallic cutlery will be perceived as being of higher quality across the world on the basis of the results obtained with UK consumers reported here. In addition, future studies applying and developing these findings to chopsticks (more commonly used in Asia) would also be particularly interesting, since they are already commonly available from a wide variety of materials (and already vary quite markedly in terms of their weight). In contrast to Western culture, the most popular types of chopsticks are made from bamboo or wood (lacquered or natural) followed by plastic, whereas metal is considered more expensive and is not chosen for daily use, in most Asian regions (Korea being one exception). In this context, the selection of materials and finishes and the variety of qualities that they could transmit to the perception of food could differ a great deal from those detected in the western cultures.

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12 Ventriloquism between tactile and oral perception of food

The influence of the feel of product packaging on the perception of the oral-somatosensory texture of food

Piqueras-Fiszman, B. & Spence, C. (2012). The influence of the feel of product packaging on the perception of the oral-somatosensory texture of food. *Food Quality and Preference, 26,* 67-73.

Abstract

Most of the published research on the perception of food texture has focused on what happens in-mouth during consumption. It is, however, important to note that people's judgments of food texture can also be influenced by other sensory cues, such as haptic input, be it their direct contact with the food, or possibly also their indirect contact with the product packaging as well. The aim of the present study was to investigate whether changing the surface texture of the product packaging would affect people's perception of the product contained within—that is, we wanted to know whether the feel of the packaging held in a consumer's hand would influence the perceived texture of the food. Participants tasted biscuits and yoghurt samples from pots (yoghurt containers) that varied in terms of their surface texture (rough/granular vs. smooth). Additionally, the foodstuffs also varied in terms of their texture (crunchiness and thickness, respectively). In a 2x2 experimental design, the participants assessed the texture of the foodstuff and their liking for it while holding the pot in their non-dominant hand. The results revealed that the texture of the container influenced participants' ratings of certain of the texture attributes being assessed, namely the most related ones. These findings shed light on the importance of nondiagnostic haptic cues (defined as those that objectively should not identify or prompt any effect) in the perception of food. These results, explained in terms of sensation transference, could have important implications for the food packaging and hospitality sectors.

Keywords: Haptic input; texture; consumer behaviour; sensation transference; perception

1. Introduction

Texture plays a crucial role in determining food quality, its acceptance by consumers, and eventually their preferences (e.g., Guinard & Mazzuchelli, 1996; Szczesniak, 2002). Bourne (1975, p. 259) defined food texture as *'the response of the tactile senses to physical stimuli that result from contact between some part of the body and the food'*. Other researchers have also included a contribution from the other senses, such as vision, hearing, olfaction, and kinesthesia in their definition (e.g., see Szczesniak, 1990). So, for example, Bult, de Wijk, and Hummel (2007) demonstrated that the perceived thickness and creaminess of milk-like products could be influenced by the retronasal presentation of an olfactory stimulus (namely, a cream odour). This effect was absent when the odour was presented while the product entered the mouth, increased when it coincided with oral mastication, and was most pronounced when it was presented while the participants were swallowing. Similarly, Zampini and Spence (2004, 2005) have demonstrated that people's ratings of the crispness of potato chips and the carbonation of a fizzy beverage (cf. Chandrashekar, Yarmolinsky, von Buchholtz, Oka, Sly, Ryba, & Zuker, 2009) can also be modified as a function of the crisp-biting or carbonation sounds that they happen to hear.

The majority of the published research on the perception of food texture has focused on what occurs inside the mouth and hence on the mechanoreceptors (located around the oral cavity) involved in that phase of consumption. However, it is important to note that people can also evaluate a food's texture using their other senses, including vision, hearing, and via non-oral haptic information (e.g., while handling a foodstuff with the hands or else with utensils, such as, for example, cutlery). Focusing attention on the latter, it has recently been demonstrated that the haptic information we receive from our hands while eating can affect the perception of the texture of whatever we happen to be eating. In one intriguing study, Barnett-Cowan (2010) had blindfolded participants rate the freshness/staleness and the crispness/softness of a series of pretzels while biting into either the fresh or stale end of a pretzel. Barnett-Cowan manipulated the congruency between the tactile/haptic information provided to the participants' hand and that provided to their mouth. In half of the trials, the participants were given a half fresh-half stale pretzel (incongruent conditions); whereas in the remainder of the trials, they were given either a whole fresh or stale pretzel (congruent condition). The results revealed that in the incongruent conditions, the stale half of the pretzel was perceived as significantly fresher and crispier in-mouth because the hands held what felt like a fresh pretzel, and vice versa. Such results

suggest that the perceived texture of food in-mouth can be altered simply by changing the haptic information provided to the consumer's hands.

In a similar vein, Piqueras-Fiszman, Harrar, Alcaide, and Spence (2011) recently demonstrated that yoghurt samples were perceived as being significantly more dense (and more satiating; Piqueras-Fiszman & Spence, 2012a) when consumed from a heavy bowl than when exactly the same yoghurt was consumed from an identical bowl that was somewhat lighter. These results suggest that any haptic cues provided by the containers used to consume food can also influence our in-mouth perception of its textural properties. In this case, however, given that the participants did not touch the food directly with their hands, the phenomenon observed might reflect an example of 'sensation transference' (Cheskin, 1957; Spence & Piqueras-Fiszman, in press) between what participants feel in their hands and what they perceive in their mouths (i.e., orally). Sensation transference has been defined as the phenomenon whereby certain sensory attributes of a product perceived via one or more of the senses (such as vision and touch) can bias a consumer's perception of other product attributes derived from other sensory modalities into alignment, and by so doing, modulate a person's overall (multisensory) product experience. It was Cheskin (1957) who in his early market research reported that different shapes on the graphics or changing slightly the overall sensory attributes (e.g., shape, colour) of a container changed the way in which consumers responded to the beverage or food within (see also Hine, 1995; Spence & Ngo, in press).

Here, it is worth differentiating between *diagnostic* and *nondiagnostic* haptic cues, and their influence on the evaluation of products and on people's judgments of various other stimuli (e.g., Ackerman, Nocera, & Bargh, 2010). The latter (i.e., the nondiagnostic cues) consist of those that are not objectively relevant to the judgment of the product, as for example, evaluating the quality or price of a dessert based on whether one consumes it using either a plastic or metallic spoon. In priniciple, the quality of the dessert should be judged independently of the feeling of the cutlery that just so happens to be used to consume it, but this turns out not to be the case (Piqueras-Fiszman & Spence, 2011, see also Piqueras-Fiszman & Spence, 2012b). Previous research has demonstrated the importance of nondiagnostic haptic information on consumer perception: For instance, Krishna and Morrin (2008) reported that water samples were perceived as significantly higher in quality when participants were not able to touch or hold the flimsy plastic cup in which the water sample was served than when they were. Such results suggest that changes in the

haptic qualities of a product's packaging (or, for that matter, in any of the utensils used to consume that product) might have important effects on a consumer's appraisal of the quality of the product not to mention on their global experience (see Hummel, Delwiche, Schmidt, & Hüttenbrink, 2003; Schifferstein, 2009; Spence & Gallace, 2011).

What is more, given that sensory perception is intrinsically related to hedonism, the hedonic attributes of a product perceived via one modality (such as touch) can bias a consumer's appraisal of the quality and pleasantness of a multisensory product as experienced by other sensory modalities (Spence & Gallace, 2011). This effect, known as '*affective ventriloquism*', could therefore be thought of as a specific (i.e., hedonic) form of sensation transference.

However, to date, there has been no empirical evidence demonstrating the effect of the surface texture of a food's packaging (or of the utensils used in its consumption) on people's ratings of the oral-somatosensory textural properties of the food itself. Therefore, the aim of the present study was to explore how the tactile (mainly surface textural) attributes of product packaging can affect people's perception of the product that happens to be contained within—that is, how the feel of a package held in a consumer's hand may modulate the perceived texture of the food it contains. Given the research that has been conducted so far on this topic, we expected that the use of packages having a feel that was congruent with the texture (crunchy or creamy) of the product within would enhance the product's intrinsic characteristics and result in more positive judgments regarding the product by customers. However, contrast effects might also be expected, given Zampini, Mawhinney, and Spence's (2006) findings concerning people's perception to the roughness of the tip of a deodorant stick, as a function of the texture of the part of the deodorant stick that was held in their hand. The present study also explored whether the sensory qualities that certain properties of product packaging convey, either merely visually or haptically, match those perceived at 'the moment of truth' (that is, when tasting the product).

2. Materials and methods

2.1. Participants

Fifty-eight volunteers took part in the experiment. The participants were randomly recruited at the Department of Experimental Psychology (Oxford University) and other public places, based on their interest in taking part in the study. At the recruitment stage, no information about the specific aim of the study was provided. All of the participants confirmed that they had no clinical history of major disease and that their

senses of smell and taste were not impaired. The age of participants' ranged between 18 and 60 years (M= 25.4 years, SD= 8.8), and 35 were female. The procedures were explained to all participants in detail and informed consent was obtained prior to participation.

2.2. Stimuli

The participants were given eight stimuli. They consisted of a yoghurt-like pot that contained either a crunchy stimulus (pieces of digestive biscuits), or a creamy stimulus (yoghurt). The containers varied in terms of the surface texture of the container (smooth vs. rough), while the food samples varied in terms of the degree of either creaminess or crunchiness (two levels for each). The containers used for the experiments were commercially available dessert/yoghurt-like pots. For the smooth condition, the packages were simply painted white. For the rough/granular condition, the same packages were covered with rough sandpaper (P60) and then painted white (see Figure 12.1). Note that the sandpaper also made the package somewhat stronger (more rigid) too.

Figure 12.1. The two pots containing the food that was given to the participants.

The crunchy stimuli consisted of squared cut pieces (approx. 2cm) of digestive biscuits (Tesco, UK). To alter their texture and create a slightly 'soggy' feel in one of the conditions, some were left in an open container (as opposed to an airtight one) for the 24hrs prior to the participant's scheduled time. Prior to cutting them, the texture of five biscuits of each condition was measured using a TA.TX.plus Texture Analyzer (Stable Micro Systems, Godalming, UK) to get an objective measure of their texture.[5]

[5] A test speed of 1mm/s was used for all the tests. The biscuits were fractured using the three point bending rig probe (A/3PB). The experimental conditions were as follows: distance between supports: 50mm; probe travel distance: 10mm; and trigger force: 10g. All the biscuits fractured in tension and fracture took place

Figure 12.2 shows the force (N)-displacement (mm) curve registered for a biscuit of each condition.

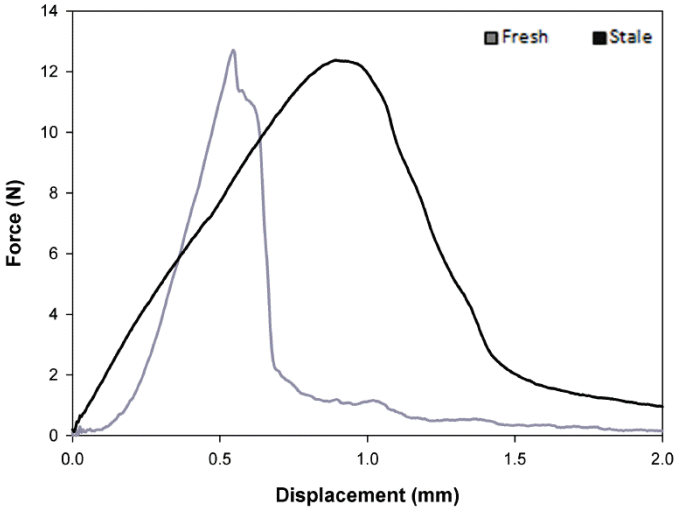

Figure 12.2. Examples of the force (N)-displacement (mm) curves registered from a fresh and a stale biscuit, where completely different breaking behaviour can be observed.

The creamy stimuli consisted of low fat plain yoghurt (Tesco, UK). For the creamier stimulus, 40g of extra thick double cream (50.5% fat; Tesco, UK) was added per 100g of yoghurt.

2.3. Procedure

The instructions were given to participants at the start of the experiment, explaining that new food products were being testing. Half of the participants received the four biscuits samples first, while the others received the yoghurt samples first. Among each group, the four stimuli samples (2x2) were coded with a three digit number for identification purposes and randomly presented to the participants following a complete block experimental design (William's Latin Square) in monadic sequence. The experiment therefore varied in the level of texture congruency.

The participants held each container (either with yoghurt or biscuit pieces) in one hand as they would do naturally. The experimenter left them holding the container for around 10s before the tasting started, while pretending to be preparing the next

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relatively close to their central zone, where maximum stress occurred. This implies that the condition regarding distance between supports was satisfied.

questionnaire. The yoghurt stimulus (10g) was given with a plastic spoon in their free hand for them to hold it and taste the sample. This ensured that all participants tasted the same amount and that the stimuli looked the same (the pots were filled with 200g of yoghurt). For the biscuits, they were told to take a piece or two from the container (which initially contained 15 pieces).

For each condition, the participants were instructed to fill in a paper-and-pencil questionnaire concerning the food they were given after tasting a spoonful/ piece of each sample given. The questionnaire included written instructions as well. A 10-cm unstructured scale anchored with “not at all” and “extremely” was used to rate the yoghurt samples in terms of their creaminess, thickness, and granularity, and the biscuit samples in terms of their crunchiness, freshness, and hardness. Though previous research has demonstrated that certain of these textural attributes are positively correlated and interdependent (Guinard & Mazzucchelli, 1996), they are still subtly different, and we wanted to check the extent to which the presented haptic cues enhanced one or the other. To rate acceptability, the consumers had to score their overall liking using a 9-point hedonic scale, anchored with “extremely dislike” and “extremely like”. During the rating process, there was no space available for the participant to put the pot down, hence ensuring that the participants had to hold it throughout. The participants were also instructed to rinse their mouth out with filtered natural water between tastings. After the complete evaluation and data collection, the participants were debriefed as to the purpose of the study.

2.4. Data analysis

For both experiments, a repeated measures analysis of variance (ANOVA) was performed in order to determine the effect of the pot’s (packaging’s) surface texture on the participants’ perception of the attributes that were being assessed. The texture of the packaging’s surface and the texture of the foods, together with their interaction, and the participant effect were considered as explanatory variables. When the effects were significant, honestly significant differences were calculated using Tukey’s test. Differences were considered significant when $p \leq .05$.

3. Results

3.1. Biscuits

The ANOVA revealed a significant main effect of the surface of the pots for both perceived crunchiness ($F_{1,228}= 7.69$, $p= .006$) and hardness ($F_{1,228} = 3.93$, $p= .048$) of the biscuit pieces. On average, the biscuit samples from the rougher pot were rated as

being significantly crunchier and harder than those from the smoother pot ($p < .05$, for both comparisons). The rough surface increased the ratings of these two attributes similarly for both the stale and fresh biscuits, since the interaction between 'surface of pot' and 'texture of food' was not significant (see Figure 12.3 for the results). Freshness and liking ratings were not affected by the variation in the texture of the surface of the pot ($F_{1,228} = .03$, $p = .86$; $F_{1,228} = 1.86$, $p = .17$, respectively), but only by the texture of the food itself, where the fresh samples were, unsurprisingly, perceived as being fresher and more liked than the stale biscuits, regardless of the pot (packaging) in which they were presented.

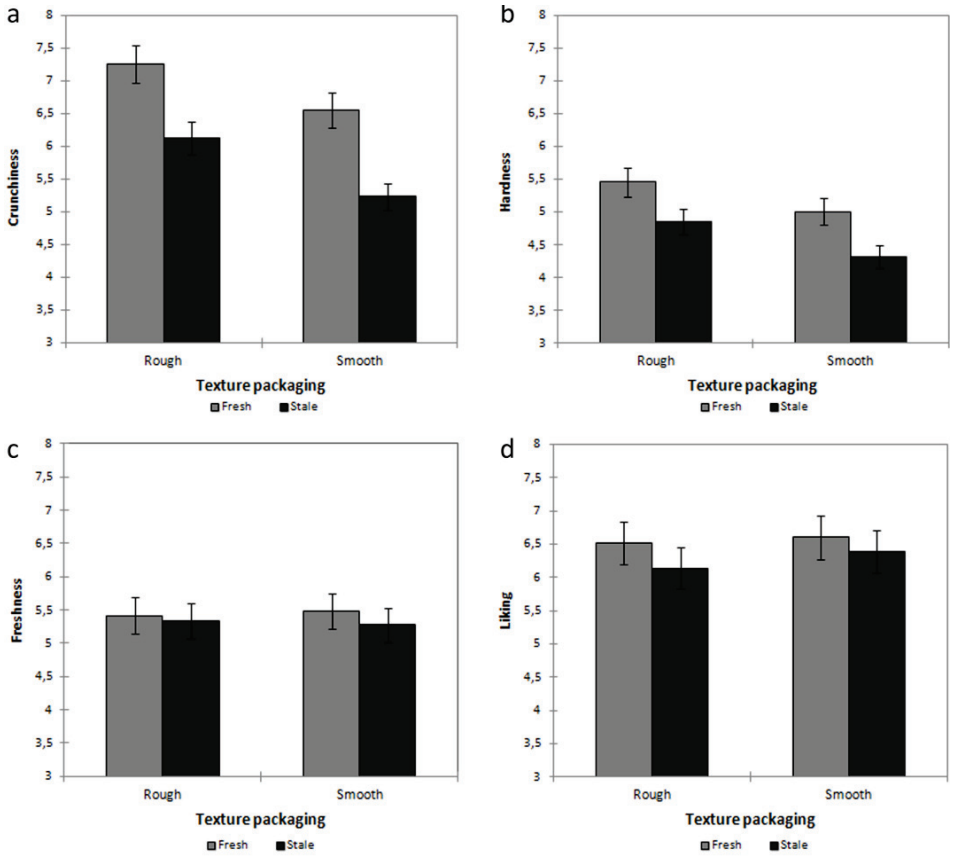

Figure 12.3. Mean ratings in a 10-cm unstructured scale of: a) crunchiness, b) hardness, c) freshness, and d) liking, as a function of the surface of the pot and the texture or the biscuit sample. Error bars represent Tukey's honestly significant differences at $p < .05$.

3.2. Yoghurt

For the yoghurt experiment, the surface of the pot did not exert a significant effect on any of the attributes ($F_{1,228}$ = .16, p= .68 for creaminess; $F_{1,228}$ = .28, p= .60 for thickness; $F_{1,228}$ = 1.17, p= .28 for granularity; and $F_{1,228}$ = 1.36, p= .24 for liking). In fact, some of the mean ratings given in the rough and smooth conditions were nearly equal (M= 6.9 vs. 7.0, for creaminess; M= 4.9 vs. 4.6 for thickness; M= 1.9 vs. 1.5 for granularity; and M= 5.5 vs. 5.7 for liking). However, it is worth noting that the sample served from the rougher pot was perceived as being 13% more granular than the identical yoghurt when served in the smooth pot (see Figure 12.4 for the results).

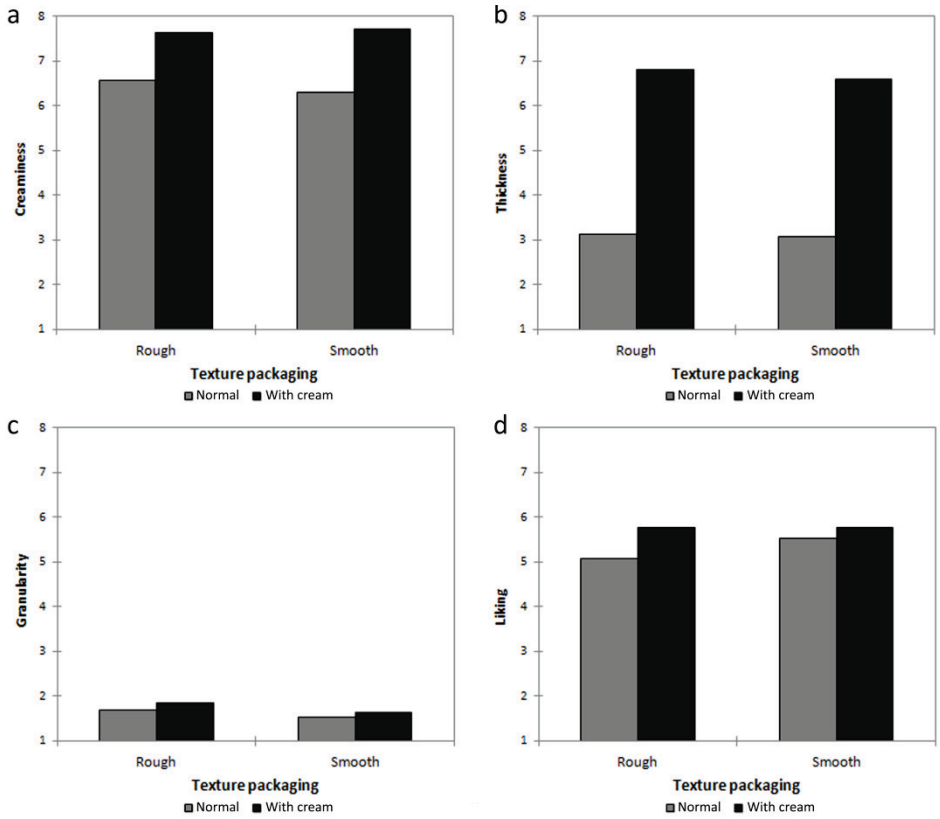

Figure 12.4. Mean ratings in a 10-cm unstructured scale of: a) creaminess, b) thickness, c) granularity, and d) liking, as a function of the surface of the pot and the texture or the yoghurt sample.

4. Discussion

On the basis of the results obtained in the present study, it would seem that participants' ratings were affected by the information presented to their mouth and hand, but only in those cases in which the textural attributes of the pot were somewhat congruent with the textural attributes of the food being assessed. This was the case for ratings of crunchiness and hardness when sampling the biscuits: Though the participants were explicitly instructed to rate the biscuits samples, the haptic input of the pot apparently interfered with their oral perception (or at least their ratings) of the biscuits, even if it consisted of a non-diagnostic haptic input (Krishna & Morrin, 2008). Having said that, it would have also been interesting to study whether the tactile properties of the package could have affected participants' perception of the texture of its contents only by touch (not orally).

In Barnett-Cowan's (2010) pretzel study, freshness was also influenced by the haptic information when handling the pretzels (directly with the hands). However, this result is more comprehensible given that people can judge the freshness of certain foods by feeling their firmness and crunchiness, even by touching the food with only a single finger (diagnostic haptic cue). In the present study, the roughness and hardness of the pot with sandpaper interfered with the participants' oral-somatosensory perception of crunchiness and hardness, but it did not affect their freshness ratings to any great extent.

As for the yoghurt experiment, several arguments can be put forward to explain the absence of any kind of influence. First, it could be argued that texture (i.e., roughness) may be a more salient aspect of crunchy food products than of soft/creamy ones. That is, we become more aware of the oral-somatosensory texture we feel the more complex it is. Second, it could perhaps be argued that yoghurt requires less oral processing as compared to the oral mastication required for dry biscuits, that require a breakage of the product structure, and hence more time and effort in swallowing the bolus. The shorter oral processing time in the case of the yoghurt might not have left much time for any sensation transference to have taken place. Finally, perhaps consumers only transfer those qualities that happen to be meaningful and congruent (i.e., shared as descriptors of the packaging/cutlery, etc, and of foodstuff itself; see Spence, Harrar, & Piqueras-Fiszman, 2012). Given that the texture used (the roughness of the sandpaper) was perhaps not congruent (perhaps its variation can even be said to be orthogonal) to the creaminess of the yoghurt, no effects were observed. Perhaps

using smooth pots varying in shape (e.g., from more rounded to more angular) or cutlery varying in texture might give more significant results (cf. Becker *et al.*, 2011; Spence & Piqueras-Fiszman, in press).

One possible limitation of the present study is related to the fact that the haptic orientation of the participants (that is, an individual's need and preference for touch; see Peck & Childers, 2003a, b) was not assessed. Prior research on the haptic orientation of consumers has shown that people with different scores on the 'Need-for-touch' test (i.e., differing in their liking, and expertise, to touch products) are influenced differently by their sense of touch when judging a product. For example, Krishna and Morrin (2008) reported that nondiagnostic haptic cues only tended to affect the perceptions and evaluations of low autotelic consumers (i.e., those with a lower need for touch). Such results suggest that the variability found in the perception of the biscuits or yoghurt samples tested in the present study could be in part explained by the participants' level of haptic orientation. Applying Krishna and Morrin's explanation, it might have been the case that those participants who would have been classified as high autotelic (with a greater experience in touching products) would have been somewhat more conscious about the fact that what they were touching was not diagnostic for the product's oral-somatosensory evaluation. Therefore, they might have known that they should discard what they were feeling in their hand when rating their oral-somatosensory experience of the foodstuffs in-mouth. On the other hand, it might also be the case that those participants who would have been classified as low autotelic did not even notice any difference in the textures of the various yoghurt pots. Perhaps surprisingly, when asked at the end of the experiment, certain of the participants tested in the present study reported not having been aware of the different textures of the pots, and that all they took notice of was the fact that any brand information had been intentionally hidden (in fact, the majority did not appear to pay any special attention to the pots that they were given to hold). This therefore raises the question of the extent to which being fully conscious of the haptic input influenced the perceptual transference observed. In any case, in future studies, it would perhaps be interesting to segment the participants in terms of their haptic orientation in order to gain a better insight into the pattern of results obtained from such touch or texture-related studies.

In addition, at the end of the experiment, but prior to debriefing, the participants were presented with two different pots, and in each case, they were informally questioned as to which container would they expect to contain crunchier biscuits, and creamier

yoghurt. Nearly all of the participants replied that they would expect crunchier products from the rough container and creamier yoghurt from the smoother one. What this admittedly anecdotal result suggests is that haptic cues present in product packaging might elicit strong (albeit likely subliminal) associations and expectations about the likely sensory attributes of the product contained within, in line with Ares and Deliza's (2010) findings demonstrating that rounder yoghurt containers are associated with creamier contents in the minds of consumers (see also Overbeeke & Peters, 1991; Smets & Overbeeke, 1995). In some cases, these expectations may affect a consumer's subsequent sensory product experience (e.g., Becker, Van Rompay, Schifferstein, & Galetzka, 2011; Siegrist & Cousin, 2009). However, in the case of the yoghurts, the sensory expectations concerning the yoghurt packaged within did not necessarily match the perceived sensory properties when it was actually tasted.

Capitalising (perhaps unconsciously) on the phenomenon of sensation transference, the last few years have seen a number of very successful developments in the tactile aspects of food packaging design giving a surface feel that is multisensorially-congruent with the product within (e.g., see Anon, 2010; see Spence & Gallace, 2011, for a review). For instance, some brands have treated the packaging of their crustless bread with a soft-touch lacquer in order to suggest the softness of the bread contained within (see also Brown, 1958). Furthermore, at the EuroBest advertising awards, held in 2010, Mario Haller Schnapps presented their prototypes for a series of labels for bottles of spirits whereby different gradations of roughness on the label were used to convey (haptically) the strength of the brandy contained within Spence & Piqueras-Fiszman, in press; cf. Zampini *et al.*, 2006) – The rougher the texture of the label, the higher the alcohol content. Here, it is also worth noting that many plastic containers for honey come in the shape of a drop (or a viscous liquid), and some even include in their silhouette the characteristic ridges formed when this viscous substance is poured, conveying the oral-somatosensory texture of the honey (see Spence & Piqueras-Fiszman, in press, for a review). The results of the present study may have important implications for the food industry, but obviously more research is needed in order to learn about which stimulus combinations are particularly effective. For example, if the effect depends on the consumers holding the container during consumption, the practical applications would probably be limited. Alternatively, if the effect holds even when the handling and consumption episodes are separated in time, or even when the container only has to be visible, then it would represent an interesting direction for future packaging research, and the applications would be widespread.

5. Conclusions

The research presented here sheds light on the importance of the effect of nondiagnostic haptic cues on product perception in the food sector, for packaging and brand managers, and those working in the hospitality sector. Though this study supports the idea that any haptic input provided by the containers in which foods and beverages are packaged - and sometimes consumed from - influences the perception of their related sensory qualities, more research should be carried out in order to determine those congruent combinations of product/packaging attributes that could possibly enhance a specific attribute of a product, and even the overall consumption experience.

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13 General discussion

A great deal of research has studied consumers' perception of foods and beverages, together with all the factors intervening in this multisensory process. However, what is often overlooked is the fact that foodstuffs are never presented in isolation to the consumer. Consequently, relatively little importance has been given to the effects that the elements that surround the food (be it the tableware or the packaging) may have on our sensory discriminative and affective perception of foods (and beverages). This thesis has reviewed the latest evidence demonstrating the importance of these contextual variables on the consumer's expectations, sensory and affective perception of, and behavioural response to, a variety of food and drink items. The results of the research outlined here demonstrate that these can all exert a significant effect on our expectations, perception of, and behaviour toward, foodstuffs.

Throughout the different chapters, it has been shown that through the interaction with a package or the tableware (on occasion, even merely visually), consumers integrate the information provided by these elements with the intrinsic properties of the food into their global perception and appraisal of the food product. The findings will be summarized here in the order in which we normally interact with food products, first creating associations and expectations (from the packaging, as in a supermarket), and then consuming it and seeing how the different elements intervene in the multisensory perception process.

For instance, it has been shown that just by seeing a product's packaging, consumers "read" the signs or elements present and elicit an array of meanings, ranging from sensory-related references (of the expected product) to memories or emotions. Some of these elicited associations, namely those related to emotions or to hedonic appraisals, depend mainly on individual traits that are built up over the course of a consumer's (or group of consumers') experience (e.g., see the age differences revealed in Chapter 3). Regarding those judgments (or expectations) about the likely sensory attributes of a product (e.g., its flavour), which are extracted by an element of the packaging (such as its colour), it is suggested that they are most probably based on learned combinations of different stimuli with which consumers are acquainted with. Chapters 4 and 5 suggest that associations between colour and flavour that consumers may have for certain product categories are actually learned from those combinations used by food companies to make consumers identify their products more efficiently. Hence the consumers build up those associations which they are more acquainted with through constant exposure to the given product. In fact, some consumers hold such a strong association that they are not able to identify the flavour of the food (in the

study case shown, crisps) when consumed from a package of another colour (they even identify another flavour, i.e., their vision dominates their taste; cf. Chapter 4). However, when consumers have no preconceived colour-flavour combination, then it is suggested that they would pair up a flavour to the colour that is more representative of the main ingredients (a more natural type of association).

It is worth highlighting that consumers also grab the products and feel it in their hands. From this act, and for certain product categories, the weight of the package is correlated to the products price, and in occasions, quality. This was what was observed from the data analysis of more than 500 bottles of wine from different regions (cf. Chapter 6). What is more, when wine consumers were asked about their beliefs, the most naïve sector did believe that more expensive and higher quality wines came in heavier bottles. Hence, not necessarily being true in the case of quality, consumers do build expectations about the likely quality of the wine, just by feeling the bottle in the hands.

When it comes to testing the impact of visual and haptic inputs on the perception of food, the studies performed in this thesis documented a variety of different effects. In terms of understanding these various effects, there appear to be a number of potentially relevant psychological and physiological explanations. Visual perceptual effects might clarify some of the above-mentioned influences of vision (more precisely colour) on food perception. Colour contrast, for example, might explain why food on a white plate might taste stronger than the same food presented on a black plate (cf. Chapter7). Psycholinguistic (or semantic) transference might result in descriptions of cutlery, plates, cups, or labels being transferred onto the food (e.g., a “heavy” bowl results in the perception of food that is rated as being heavy, which is commonly related to density and feelings of satiation; cf. Chapters 9 and 10). Sensation transference might, partially account for the fact that properties of the tableware or packaging are associated with the food and drink. Low-level attributes of the accessories (such as colour or texture; cf. Chapters 8 and 12 respectively) might be transferred to the consumables, just as high-level attributes seem to be (such as their perceived quality and expense; Chapter 11).

Together, these factors help to explain the growing body of evidence demonstrating that both the tableware and the packaging can have a profound effect on our perception of foods and drinks.

Perceptual matters

A number of possible explanations for the transference effects observed have been described throughout the present thesis. Some of these involve crossmodal interactions between certain sensory attributes of the extrinsic element and the food (in occasions triggered by crossmodal correspondences/ associations); others involve a quality and/ or hedonic transference; others a semantic transference, and others a perceptual dimension. However, it is important to highlight the complexity in their definition. Many of the concepts are closely linked, often interlaced, and being able to discern them can be quite challenging. In addition, as commented in the introduction, the interpretation of the results (*what* is being influenced) can become complex in terms of distinguishing between what the participants *were aware of perceivin*g and what they *reported to perceive*, which involves a reflection. Furthermore, there might be biasing effects, such as the halo effect or the dumping effect, in the participants' ratings, which are especially relevant in studies where crossmodal interactions are part of the focus. These biases would call into question the interpretation regarding the origin of the transference and the generalizability of the observations.

Although these questions are not particular of the topic of the present thesis, they are brought in this section to highlight the complexity of food perception (particularly of heterogeneous foods), and its interpretation, at least with traditional methods, as those used in many of these studies (i.e., rating methods).

Methodologies used

Regarding the methodological approaches, the range of techniques selected for each purpose has proved to be useful to achieve the aims of each study. In spite of not having been recently developed, their application is relatively novel in the sensory science research area, which is currently merging with experimental psychology (and even neuroscience) to get a deeper understanding of the underlying perceptual processes, behaviours, and food choices. Ranging from semiotic analysis, psychophysical experiments, to implicit behavioural tasks, and projective techniques, each of them, and even more their combination, helped to explore the participants' thoughts, on occasions conscious, and, in others, less conscious, and their perceptions of the food stimuli. However, other techniques coming from the field of neuroscience, such as neuroimaging, would be more useful in terms of revealing information that consumers are simply unaware of, and that is purely objective. These measurement would reveal possible conflicts between what people perceive (as detected by the

brain activity) and what they report perceiving, thus probably providing a more accurate measure. What seems evident is that the appropriate combination of objective and subjective measures will be key in the development of the future of food and consumer science research.

14 Conclusions

Our perception of food products is inherently multisensory. What this means in practice is that changing any one of the sensory attributes of a food product can (and, in many cases, will) have a significant impact on a consumer's overall food perception. This thesis contributes to the knowledge on crossmodal interactions and associations, and their effect on consumers' expectations and perceptions of food products. More importantly, it highlights the importance of the role that the different sensory attributes of the *extrinsic* properties of foods (e.g., the packaging or the tableware in which the food is presented, and/ or consumed from) can have in the perceptual process of the consumer.

Taken together, the research presented provides a more scientific framework in which to explain such an impact: First by introducing the reader a foundation of basic notions of consumer psychology and crossmodal mechanisms. Second, by presenting a rich body of evidence which demonstrates that the containers from which we eat and drink, and even the utensils used, influence our perception (both sensory-discriminative and hedonic) of food and beverages and the overall consumption experience to a greater extent than most of us are consciously aware of.

The case studies approach the perceptual process by looking at different combinations of sensory input (namely visual, tactile, and gustatory), which fit to different stages of the interaction between the consumer and the product. For instance, it has been studied the general messages and the crossmodal associations (and expectations) that consumers elicit while only inspecting a packaging image (as consumers do in a supermarket context). In other case studies, the procedures have involved consuming a food direct from a packaging (as when eating out), or from a plate and/ or with other tableware (as in a home or a restaurant setting). These latter cases (which explore the mixed contribution of visual, tactile, and gustatory stimuli) enabled to investigate the combined impact of these inputs (coming from different sources).

One of the key findings to have emerged from this body of scientific research is that changing any of the sensory inputs studied (from the extrinsic elements of a food product) can alter consumers' multisensory perception and experience of food, but not in an arbitrary way and for all attributes being evaluated. Instead, the results suggest that the brain integrates these external sensory inputs and transfers sensations from one modality (and source) to another based on rules such as semantic similarity, and learned crossmodal correspondences. The more challenging theoretical question becomes one of explaining why exactly such crossmodal effects occur, especially when

the effects observed depend, at least to some extent, on the particular food that happens to be under experimental consideration.

Though previous research has demonstrated the effects of consumers' personal characteristics on the results, this topic has not been explored in depth in this body of research. However, it would be particularly interesting to segment consumers based on their sensory capabilities and inclinations to use one sense or the other in order to better judge the results of a multisensory product experience. In addition, although none of the studies included in this thesis have been performed in wholly natural contexts, it would be informative to do so, since they could help to better understand and predict consumers' perceptions and appraisals in real situations.

The evidence for effects of these extrinsic elements on eating and drinking perception sheds light on the fact that the consumer's appraisal of an eating experience is constructed with much more than the sensory properties of the food itself. However, jumping to conclusions and interpreting the results of the case studies as "rules" would be a mistake. As mentioned earlier, the effects shown also depend on the food itself, as well as on the context in general (and of course, the consumer). Hence in terms applying these findings, what should be considered is that there are more elements, apart from merely the food, that can be modified in order to deliver a certain sensation or experience to the consumer. In conclusion, those sectors which might find the insights reported here useful, and which would be interested in applying them (e.g., packaging, marketing, nutrition, hospitality, gastronomy, etc.) should pay far more attention to the packaging and/ or tableware used in order to maximize the eating experience for consumers and obtain a positive response from them.

15 Other related publications

Research articles

- Varela, P., Piqueras-Fiszman, B., Ares, G., Morant, R., & Fiszman, S. (2011). ¿Qué mensaje transmiten las etiquetas del yogur? Un análisis semiótico. *Alimentaria, 421 (March),* 55-57.
- Ares, G., Piqueras-Fiszman, B., Varela, P., Morant, R., Martín López, A., & Fiszman, S. (2011). Food labels: Do consumers perceive what semiotics want to convey? *Food Quality and Preference, 22,* 689-698.
- Harrar, V., Piqueras-Fiszman, B., & Spence, C. (2011). There's more to taste in a coloured bowl. *Perception, 40,* 880-882.
- Piqueras-Fiszman, B., Laughlin, Z., Miodownik, M., & Spence, C. (2012). Tasting spoons: Assessing how the material of a spoon affects the taste of the food. *Food Quality and Preference, 24,* 24-29.
- Spence, C. & Piqueras-Fiszman, B. (2012). Multisensory design: Weight and multisensory product perception. *RightWeight2 Proceedings*, 8-18.
- Ngo, M., Piqueras-Fiszman, B. & Spence, C. (2012). On the colour and shape of still and sparkling water: Insights from online and laboratory-based testing. *Food Quality and Preference, 24,* 260-268.
- Spence, C. Harrar, V., & Piqueras-Fiszman, B. (2012). Assessing the impact of the tableware and other contextual variables on multisensory flavor perception. *Flavour, 1:7.*
- Piqueras-Fiszman, B. & Spence, C. (2012). Sensory incongruity in the food and beverage sector: Art, science, and commercialization. *Petits Propos Culinaires, 95,* 74-116.
- Piqueras-Fiszman, B. & Spence, C. (in press). Dining in the dark. *The Psychologist.*
- Piqueras-Fiszman, B., Varela, P., Fiszman, S. (in press). How does the science of physical and sensory properties contribute to gastronomy and culinary art? *Journal of Culinary Science & Technology.*

Submitted articles

- Piqueras-Fiszman, B., Velasco, C., Montejo, A., & Spence, C. Combining eye tracking and word association in order to relate attentional, cognitive, and affective information processing of the multisensory attributes of food packaging. *Food Quality and Preference.*
- Piqueras-Fiszman, B., Giboureau, A., & Spence, C. Assessing the influence of the color of the plate on the perception of a complex food in a restaurant setting. *Appetite.*

Book chapters

- Spence, C. & Piqueras-Fiszman, B. (in press). The multisensory packaging of beverages. In M. G. Kontominas (Ed.), *Food packaging: Procedures, management and trends*. New York: Nova Publishers.