Title

Hot or not? Conveying sensory information on food packaging through the spiciness-shape correspondence

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Abstract

The packaging of a product is a key element in the communication between producers and consumers, so getting the consumer to interpret the packaging visual signs in the desired way is crucial to be successful in the marketplace. However, this is not easy as images can be ambiguous and may be interpreted in different ways. For example, depicting an icon of fire on the front of a bag of nuts may lead the consumer to interpret either that the nuts are spicy or that the nuts have been roasted. This paper addresses this problem and, using this case as an example, assesses if the interpretation of a fire icon (spicy vs roasted) can be modulated by manipulating its shape (angular vs rounded). 66 participants carried out an experiment which results show that there is a crossmodal correspondence between spiciness and pointy shapes and that this association can be used to modulate sensory expectations: in a speeded classification task, the bags of nuts depicting pointy fire icons were categorised more quickly as being spicy than as being roasted, while the opposite was true for the bags of nuts displaying rounded fire icons. In addition, the results of a mediation analysis suggest that this effect occurs indirectly through affective appraisal: the pointy fire icons were judged as being more aggressive than the rounded fire icons, which in turn raised spiciness expectations. These findings contribute to the research on crossmodal correspondences and semiotics by showing that the association between spiciness and abstract shapes can be used to modulate how people interpret an ambiguous image.

Keywords

Semiotics; Expectations; Categorisation; Packaging design, Implicit measures

Highlights

- There is a crossmodal correspondence between spiciness and pointy shapes.
- That association can be used to modulate consumer sensory expectations.
- On a bag of nuts, a pointy (rounded) fire icon evokes spicy (roasted).
- Fire icon’s shape effect on expectations is mediated by aggressiveness perception.
- Both pointy shapes and spiciness are perceived as aggressive stimuli.

1. Introduction

One of the main tasks of a packaging designer is to effectively communicate the characteristics of the product contained within, as packaging is an important communication tool between producers and consumers (Nancarrow, Wright, & Brace, 1998). To that end, the designer must understand and untangle the codes and language used by consumers (Frascara, 1988; Laing & Masoodian, 2016) and, in addition, reproduce them clearly in an appealing design (Silayoi & Speece, 2007). Images allow the designer to both communicate messages and gain aesthetic quality, which is why they are frequently used in food packaging (Underwood & Klein, 2002). Images are a key element in the packaging visual appearance as they allow the consumer to quickly identify and categorize the product (Loken, 2006) and to generate expectations about it (see Deliza & MacFie, 1996; Piqueras-Fiszman & Spence, 2015, for reviews). However, for the designer it is not easy to anticipate the meaning that a consumer will assign to an image since in a given context an image can evoke different concepts (Smith, Barratt, & Selsøe Sørensen, 2015): for example, when viewing an icon depicting fire on a bag of nuts the consumer may interpret that the nuts are spicy or that the nuts have been roasted. For both designers and producers it is key to know what does the elicitation of one meaning or another depend on, as previous works suggest that for a product to succeed in the market it should satisfy consumer expectations (Piqueras-Fiszman & Spence, 2015). The investigation reported here addresses this problem by studying if it is possible to use the crossmodal correspondence between spiciness and shapes to favour one of the possible interpretations of the same image, which would allow the designer to gain control over the communication process. Specifically, we argue that the meaning implicitly assigned to an icon of fire depicted on a bag of nuts (i.e. spicy or roasted) depends on the angularity of the icon, and propose that the nature of this effect is affective.

2. Background

2.1. The image displayed in the package as a propositionally indeterminate semantic sign

The visual appearance of a package plays a key role during the categorisation process and the generation of expectations, since consumers use the different elements of the package as signs from which to infer information (Loken, 2006; Loken, Barsalou, & Joiner, 2008). Based on Peirce's semiotics (1991), Ares et al. (2011) distinguish two kinds of signs in the context of food packaging: linguistic signs (i.e. signs that produce meaning by social convention, like texts or words) and visual signs (i.e. signs that produce meaning by resemblance, like colours or images). Today we have abundant information regarding the way in which linguistic signs or some visual signs such as colour influence these processes (Kauppinen-Räisänen & Luomala, 2010; Lähteenmäki, 2013; Piqueras-Fiszman & Spence, 2015; Spence & Piqueras-Fiszman, 2014; Sütterlin & Siegrist, 2015). On the contrary, the specific effect of the images in the communication between packaging and consumer has been less studied. For example, Smith et al. (2015) showed that having an image on the package of the major taste-giving ingredient instead of a text description makes consumers believe there is a greater proportion of it in the product, while Rebollar et al. (2016) showed that products accompanied with the main product in the serving suggestion depicted on a package of fresh cheese influence the time of the day it is considered most suitable to consume it. More recent work from the same team suggest that communicating that the potato chips contained in a package had been fried in olive oil by showing an image of an oil dispenser instead of by stating it by a text increases the sensory, non-sensory and hedonic expectations of the product and increases the willingness to buy it (Rebollar et al., 2017).

However, despite the importance of transmitting a clear and unambiguous message to the consumer, the designer cannot easily anticipate the meaning that will be inferred from an image displayed on a food package. An image by itself is propositionally indeterminate and may evoke many interpretations in the mind of the consumer, since it lacks the syntactic devices necessary to emit an explicit propositional meaning (Messaris, 1994, 1997; Smith et al., 2015). For example, consider the case of depicting an image of fire on a bag of nuts: the consumer may interpret that the product is spicy or that the product has been roasted (Smith et al., 2015), as in this context *fire* may be congruently understood in either way. Although this propositional indeterminacy can be broken by making the meaning of the image explicit by using supporting text (Barthes, 1977; Phillips, 2000), the paths by which the meanings of text and image are decoded are different and can lead to different interpretations. In that case, an additional process is required to resolve the conflict and select a definitive meaning (Lewis & Walker, 1989), which may negatively affect the processing fluency and the overall attitude toward the product (Alter & Oppenheimer, 2009). In addition, it is also worth noting that the image captures attention faster than the text (Honea & Horsky, 2012; Silayoi & Speece, 2007; Venter, van der Merwe, de Beer, Kempen, & Bosman, 2011), is processed more quickly (Mueller, Lockshin, & Louviere, 2009; Underwood & Klein, 2002), and that the first impression may condition the response to subsequent stimuli (Epley & Gilovich, 2006; Madzharov & Block, 2010). Thus, effectively controlling the expectations evoked by the image is thus crucial for the designer in order to ensure that the message conveyed by all the signs displayed on the package is congruent.

2.2. Conveying spiciness through the shape of an image

The literature dedicated to crossmodal correspondences gives a hint about why it can be expected that the shape of an image depicted on a food package may influence the sensory expectations of the product contained within. Crossmodal correspondences are the often surprising associations that the majority of people seems to share across stimuli from different sensory modalities (Spence, 2011). Although many of the studies that initially analysed these effects focused on the correspondences between audition and vision (Parise & Spence, 2013; Spence, 2011), crossmodal correspondences have been documented among all sensory modalities (Spence, 2011). Specially regarding the gustatory sense, it has been shown that expected and perceived flavour may be influenced by audition (see Spence, 2015a for a review), touch (Barnett-Cowan, 2010; Piqueras-Fiszman, Harrar, Alcaide, & Spence, 2011) or vision. In this particular case, associations have been found between both flavour and taste and cues as colour (Piqueras-Fiszman & Spence, 2011; Piqueras-Fiszman, Velasco, & Spence, 2012), packaging shape (Becker, van Rompay, Schifferstein, & Galetzka, 2011; Velasco, Salgado-Montejo, Marmolejo-Ramos, & Spence, 2014) or abstract shapes (Liang, Roy, Chen, & Zhang, 2013; Velasco, Woods, Petit, Cheok, & Spence, 2016). However, the majority of the research conducted to date has focused in basic tastes and other components of flavour like the burning sensation of spiciness/piquancy[1] have been barely studied (Wang, Keller, & Spence, 2017).

Literature makes a clear distinction between the concepts of taste and flavour (Spence, Smith, & Auvray, 2014). While the basic tastes include bitter, sweet, salty, sour and umami, and are understood as the specific gustatory sensations that occur with the stimulation of receptors located in the tongue (Delwiche, 1996), flavour is a more complex multisensory perception that is processed from gustatory, olfactory (mainly retronasal) and trigeminal inputs (Spence, Smith, & Auvray, 2014; Spence, 2015). The trigeminal system is the chemosensory system responsible of mediating sensations as the cool feeling caused by peppermint chewing gum, the tingling produced on the tongue by carbonated drinks or the burning sensation while eating chili peppers (Lundström, Boesveldt, & Albrecht, 2011). The spiciness/piquant sensation that arises when you eat chili peppers or other pungent products is therefore produced by the activation of the trigeminal system receptors located in the mouth when the irritants contained in these products, such as capsaicin, are released. These receptors are the same ones that are responsible for processing temperature, pain and chemical irritation, so the sensation produced by capsaicin is processed by the brain in similar terms to those of an increase in temperature (Caterina, Schumacher, Timinaga, & Rosen, 1997). The intensity of the perceived heat depends on factors such as the concentration of capsaicin present in the food (Baron & Penfield, 1996), time elapsed between intakes (Carstens et al., 2002) or serving temperature (Reinbach, Toft, & Møller, 2009), and usually takes a few tenths of a second to reach its maximum level (Prescott & Stevenson, 1995). Although the spiciness/burning sensation produced by capsaicin is not considered a basic taste, it is described as a significant contributor to flavour perception and has even been described as "the forgotten flavour sense" (Lawless, 1989; Spence, 2015b; Tu, Yang, & Ma, 2016; Viana, 2011). As is the case with other flavour components, people seem to match spiciness with stimuli from other sensory domains such as audition and vision. Thus, both expected and perceived spiciness can be enhanced with specific sound attributes (high pitch, fast tempo or high levels of distortion; Wang et al., 2017), by manipulating the intensity of red colouring of a salsa (the more intense the red, more spicy the salsa; Levitan & Shermer, 2014) or with the colour of the plate on which a food is served (being red the spiciest; Tu et al., 2016).

In recent years there has been a growing interest in understanding shape symbolism within the framework of flavour-vision correspondences (Becker et al., 2011; Velasco et al., 2014; Velasco, Woods, Petit, et al., 2016). However, despite the burning sensation caused by pungent food being considered a significant contributor to flavour perception, to date no study has analysed the association between shapes and spiciness. Studies conducted so far show that rounded forms tend to be associated with sweet tastes, while angular forms are more commonly associated with bitter or acidic foods (Liang et al., 2013; Velasco et al., 2014; Velasco, Woods, Deroy, & Spence, 2015; Velasco, Woods, Marks, Cheok, & Spence, 2016). For example, Ngo, Misra, & Spence (2011) asked people to match shapes with chocolates varying in cocoa content (30, 70 or 90%) and found that they associated flavours that are more bitter with more angular shapes, whereas Ngo et al. (2013)

[1] Although the terms *spiciness* or *spicy* may also refer to the aroma of a given food (Spence et al., 2014), in the present paper they are used to describe the burning sensation caused by capsaicin (Caterina et al., 1997).

demonstrated that people consistently match juices rated as sweet with rounder shapes and juices that are considered sour with angular shapes. Other researchers have documented similar crossmodal correspondences with more complex flavours such as cheeses. Gal, Wheeler, & Shiv (2007) asked a group of participants to estimate the surface area of a series of geometric shapes before evaluating a group of cheeses, and they found that participants who evaluated the surface area of angular (rather than rounded) shapes perceived the cheese to taste sharper. Going one step further, Spence, Ngo, Percival, & Smith (2013) analysed the shape symbolism of each flavour component of different types of cheese (taste, smell, texture and overall flavour) and showed that crossmodal correspondences were mainly based on the taste rather than the smell or the texture. Associations have been documented even in flavours processed almost entirely by the trigeminal system: two studies that analysed the case of carbonated water showed that still water was consistently matched with rounded shapes while sparkling water was associated with angular shapes (Ngo, Piqueras-Fiszman, & Spence, 2012; Spence & Gallace, 2011). Although recent studies have challenged the idea that the same associations are universally shared and have suggested differences between cultures (Bremner et al., 2013; Wan et al., 2014), on average these effects have proven to be robust and consistent across products and groups of participants (Parise, 2016; Spence, 2011). Since shapes can apparently influence the evaluation of food regardless of whether they are seen before (Gal et al., 2007) or during consumption (Liang et al., 2013), one might expect that the shape of an image shown on a package could influence consumer's spiciness expectations (Velasco et al., 2014; Velasco, Woods, Petit, et al., 2016). Accordingly, we propose:

H1a. Spiciness will be associated with angular rather than with rounded shapes.

H1b. A product will be more easily associated with spiciness if the image depicted on its package has an angular rather than a rounded shape.

2.3. Angularity as a cue for aggressiveness

The crossmodal matching between shapes and flavours may be explained by an affective mechanism, as people's liking for a stimuli appear to influence their shape matching responses (for flavour-shape affective correspondences, see Liang et al., 2013; Velasco et al., 2015; for odour-shape affective correspondences see also Hanson-Vaux, Crisinel, & Spence, 2013; Seo et al., 2010). Given that some researchers have proposed that the associations between stimuli from different senses are mediated by emotion (Guerdoux, Trouillet, & Brouillet, 2014; Palmer, Schloss, Xu, & Prado-Leon, 2013; Schifferstein & Tanudjaja, 2004), it has been suggested that sweet-rounded correspondences and bitter/sour-angular correspondences may share an affective congruence in which sweet tastes and rounded shapes are regarded as pleasant stimuli whereas bitter/sour tastes and angular shapes are initially considered unpleasant stimuli (Bar & Neta, 2006; Steiner, 1974). In fact, a large number of studies support the idea that while organic and rounded shapes are considered pleasant and friendly, pointy shapes elicit threat and aggressiveness and are therefore more commonly disliked (Bar & Neta, 2006; Carbon, 2010; Dazkir & Read, 2012; Ghoshal, Boatwright, & Malika, 2015; Larson, Aronoff, & Stearns, 2007; Leder & Carbon, 2005; Westerman et al., 2012). Two classical studies in this field showed that there is an association between the aggressiveness of a concept and the angularity of the line chosen to represent it, as in both cases words like “hard”, “cruel” or “furious” were matched with angled lines more frequently than concepts like “merry”, “weak” or “gentle”, which were consistently paired with rounded lines (Lundholm, 1921; Poffenberger & Barrows, 1924). In a more recent study, Bar & Neta (2006) suggested that objects with angled contours trigger a greater sense of threat than objects with rounded contours, and demonstrate that the contour of an object has a critical role in people’s attitude towards it since stimuli with rounded shapes were preferred to stimuli with angular shapes. The relation between shapes and aggressiveness has been documented even in studies of human facial expression, which suggest that diagonal and angular face patterns convey threat whereas round face patterns evoke warmth (Aronoff, Woike, & Hyman, 1992). This association is implicit and automatic not only at the cognitive level (Larson, Aronoff, & Steuer, 2012) but also at the physiological level, since a fMRI test shows that an angular stimulus causes more activity in the amygdala than a rounded stimulus (Bar & Neta, 2007).

Given the above, it has been argued that a reason by which angular shapes and bitter tastes are commonly associated is because both stimuli evoke threat (Turoman, Velasco, Chen, Huang, & Spence, 2018), as many natural poisons have a bitter taste (Garcia & Hankins, 1975; Lundström et al., 2011). We hypothesize that this is also the case for spiciness, and we propose that spiciness and angular shapes share a common cognitive space in which both stimuli are rendered as aggressive. Indeed, some studies link spiciness and aggressiveness (Batra, Ghoshal, & Raghunathan, 2017). The irritation produced by capsaicin leads to the characteristic burning sensation of spicy foods, which has been related with discomfort or even pain (Bègue, Bricout, Boudesseul, Shankland, & Duke, 2015; Byrnes & Hayes, 2013) and in turn may evoke aggressiveness (Berkowitz, 1990, 1993). Therefore:

> H2. The effect of shape angularity on spiciness expectations will be mediated by perceived aggressiveness of the shape.

3. Pretests

3.1. Adequacy of the chosen stimulus

A fire icon depicted on the front of a bag of nuts was chosen as the stimulus for this experiment under the assumption that it is a propositionally indeterminate visual sign which may evoke both spicy and roasted meanings to the observer. To verify this assumption, a pretest was conducted in which 31 participants (16 female, mean age 20.7 years) completed an open-ended task. Instructions were given as follows: *“Imagine you are in a supermarket and you see a bag of nuts on which front an icon of fire is depicted. When you see fire depicted on a nuts bag, you think it means the nuts are…”*. The participants were asked to respond as quickly as possible. The elicited meanings were *Spicy* (in Spanish, *Picantes*; N=18, 58.1%) and *Roasted* (in Spanish, *Tostados*; N=13, 41.9%). No other words were elicited. The difference between the two percentages was not significant (χ^2=0.806, p=0.37), thus showing that a bag of nuts with a depiction of fire is adequate for this experiment since the fire image can be interpreted in two different ways (i.e. that the nuts are spicy or that the nuts are roasted).

3.2. Effectiveness of the icons shape manipulation

Once the adequacy of the stimulus had been checked, a total of eight fire icons varying only in their shape were designed of which four were intended to be considered angular (A, B, C and D) and the other four were intended to be rather perceived as rounded (E, F, G and H), see Fig. 1a. The stimuli were designed with Adobe Illustrator CC 2017.1.0 (Adobe Systems Incorporated, 2006). Since the shape of the image depicted on the packaging is the independent variable of this experiment, the effectiveness of the shape manipulation was verified by conducting a pretest in which 35 participants (20 female, mean age 23 years) evaluated the angularity of each of the eight fire icons. Adapting the design of Spence & Gallace (2011), participants were given a sheet of paper with eight scales (four randomly distributed on each side of the sheet) on which to place each of the fire icons (the scales can be seen in Fig. 1b). The shapes depicted on each side of the scale are the ones commonly used in this kind of experiments, representing an angular and a rounded shape on each end (Spence & Gallace, 2011). Written instructions were provided as follows: *"Please indicate where each of this icons would be for you on this scale. If you associate the icon more with the shape on the left, make a mark in the left part of the scale. If you associate it more with the shape on the right, make a mark in the right part of the scale. Draw the mark closer to a shape the clearer you see the association with it."* The scale was 10 cm long and had a vertical line marking the mid-point of the line. Responses were measured using a ruler, assigning a value of zero to the mid-point of the scale. Responses on the left half of the scale were registered as negative values and responses on the right half as positive values. A one sample t-test was conducted with zero (the mid-point of the scale) as the test value. Results show that each of the four fire icons designed to seem angular rather than rounded were indeed more associated with the angular shape than with the rounded shape (A: $\bar{X}$=-3.47, $t(65)=-11.64$, $p<0.001$; B: $\bar{X}$=-2.44, $t(65)=-9.85$, $p<0.001$; C: $\bar{X}$=-1.45, $t(65)=-5.20$, $p<0.001$; D: $\bar{X}$=-1.09, $t(65)=-4.86$, $p<0.001$) and that each of the four icons which shape was intended to be considered more rounded than angular were more associated with the rounded rather than the angular end of the scale (E: $\bar{X}$=2.15, $t(65)=12.42$, $p<0.001$; F: $\bar{X}$=2.50, $t(65)=9.72$, $p<0.001$; G: $\bar{X}$=2.71, $t(65)=11.32$, $p<0.001$; H: $\bar{X}$=3.49, $t(65)=16.00$, $p<0.001$; see Fig. 1b).

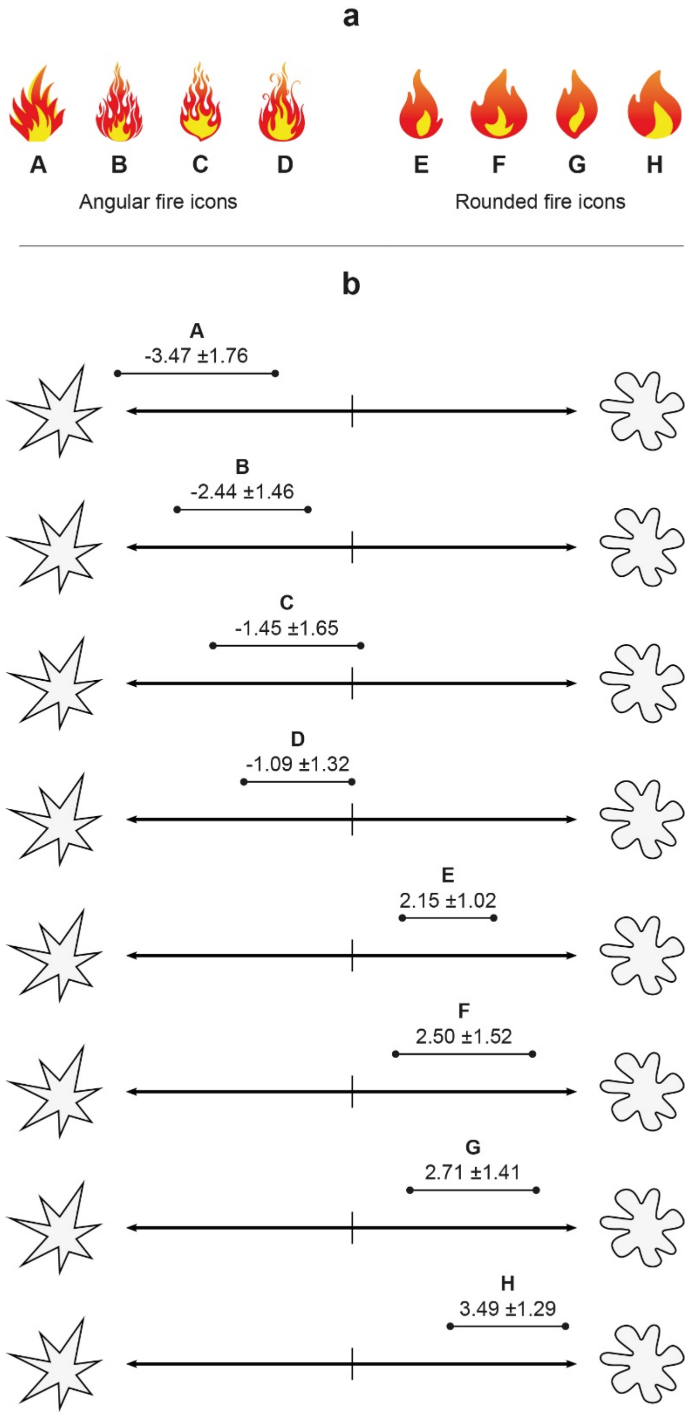

Fig. 1. (a) The eight fire icons designed as the stimuli for the experiment; (b) the eight scales used to measure the effectiveness of the icons shape manipulation. Each scale was 10 cm long. The vertical lines represent the mid-points of the scales. The participants' mean response ± the standard deviation (SD) is represented above each scale.

Additionally, a Ward's hierarchical cluster analysis using squared Euclidean distances as proximity measures revealed that the four fire icons rated as angular made up a single angular icon cluster and that the four icons rated as rounded formed a unique rounded icon cluster (Table 1; see also Dendrogram in Fig. 2). According to this results, the four angular fire icons were henceforth analysed as a single 'angular' fire icons set and the four rounded fire icons as a single 'rounded' fire icons set.

Table 1

Ward's hierarchical cluster analysis

Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	G	H	31,585	0	0	4
2	E	F	74,675	0	0	4
3	B	C	126,690	0	0	5
4	E	G	192,418	2	1	7
5	B	D	263,756	3	0	6
6	A	B	443,602	0	5	7
7	A	E	2218,866	6	4	0

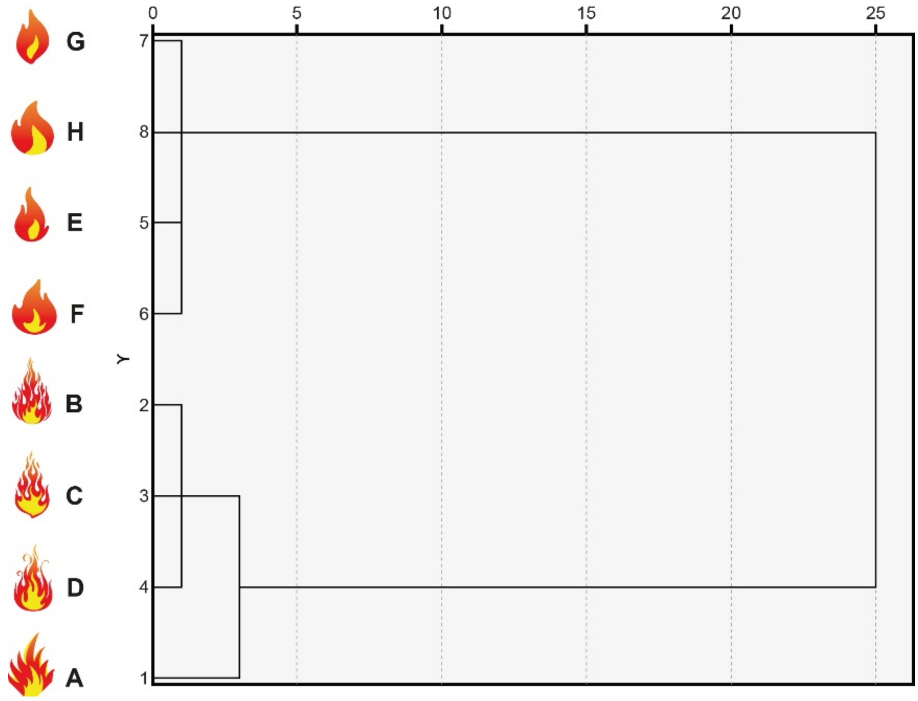

Fig. 2. Dendrogram obtained by means of Ward's hierarchical cluster analysis

Eight bags of nuts varying only in the shape of the fire icon depicted on its front were created with Adobe Photoshop CC 2017.1.1 (Adobe Systems Incorporated, 2006) based on the findings from these pretests (Fig. 3).

Fig. 3. Example of an angular fire icon (left) and a rounded fire icon (right) bag of nuts designed for the experiment

4. Materials and methods

4.1. Participants

66 undergraduate students (35 female, mean age 20.7 years, sd=2.49) from Zaragoza University took part in this experiment in exchange for being included in a raffle for gift vouchers in a well-known online store. All the participants performed the experiment voluntarily and did not know the real objectives of the study.

4.2. Apparatus and materials

The experiment took place in a quiet room with stable and homogeneous conditions of light and temperature in the Escuela de Ingeniería y Arquitectura of Zaragoza University. Upon arrival, each participant was seated in a single cubicle about 50cm in front of a 17" CRT monitor with a resolution of 1366 x 768px and a refresh rate of 60Hz, and performed the experiment following the instructions shown on the screen. The software used was OpenSesame 3.1.9 (Mathôt, Schreij & Theeuwes, 2012).

4.3. Design and procedure

The experiment was conducted following a within-subject design that was divided in three parts (Fig. 4). Part order was the same for all the participants. In the first part, the participants were asked to indicate their association between spiciness and shape angularity. In the second part, they were asked to rate the perceived aggressiveness of each of the eight fire icons designed as stimuli for the experiment. The fire icons were displayed one at a time on the screen following a random order. Then, the third task consisted on a speeded classification task in which the effect of the shape angularity of the fire icons on sensory expectations was measured. Finally, demographic information was collected and participants were thanked and debriefed. The experiment lasted from 10-15 min per participant.

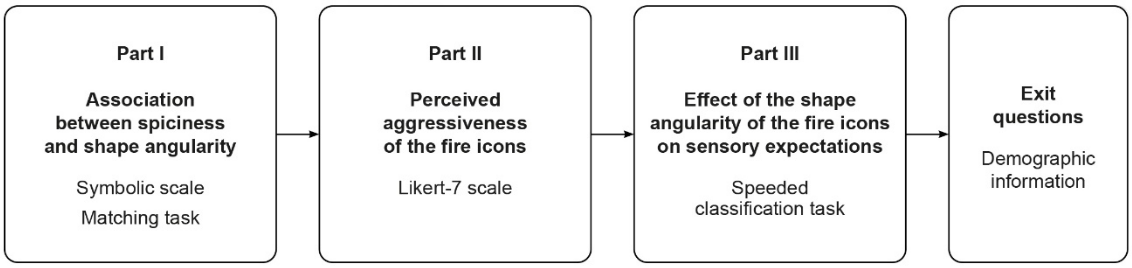

Fig. 4. Outline of the main study

4.4. Measures

4.4.1. Association between spiciness and shape angularity

The association between spiciness and shape angularity was measured by asking the participants to indicate where would they place spiciness on a scale with an angular shape at one end and a rounded shape at the other, following an identical design to that of the pretest described in section '*3.2. Effectiveness of the icons shape manipulation'*. Written instructions were provided as follows: *"Please indicate where spiciness* (in Spanish, *sabor picante*) *would be for you on this scale. If you associate spiciness more with the shape on the left, make a mark in the left part of the scale. If you associate it more with the shape on the right, make a mark in the right part of the scale. Draw the mark closer to a shape the clearer you see the association with it."* The scale was 10 cm long and had a vertical line marking the mid-point of the line. Scale responses were measured using a ruler assigning a value of zero to the mid-point of the scale. Responses on the left half of the scale were registered as negative values and responses on the right half as positive values.

In addition, the participants were asked to indicate where would they place the roasted flavour (in Spanish, *sabor tostado*) on a second identical scale to check (1) if a crossmodal correspondence also exists between roasted flavour and shape angularity and (2) if so, to verify that it is not as strong as the one between shape angularity and spiciness. In this regard, the participants also performed a matching task in which they indicated which of the shapes displayed in the scale (the angular one or the rounded one) would they associate with spiciness and which one would they associate with the roasted flavour. The purpose of this task was to check if, when forced to decide, the participants would match the angular shape with spiciness and, consequently, the rounded shape with the roasted flavour.

4.4.2. Perceived aggressiveness of the fire icons

The perceived aggressiveness of each of the fire icons was measured according to a Likert scale of 1 (not aggressive at all) to 7 (strongly aggressive). In order to avoid priming (Johnston & Dark, 1986), participants also had to rate each icon according to three other concepts used as distractors.

4.4.3. Effect of the shape angularity of the fire icons on sensory expectations

The effect of the shape of the fire icons on consumer sensory expectations was implicitly measured by means of a speeded classification task. During this, following a design similar to that of the *taste response task* reported by Velasco, Woods, Marks, et al. (2016), the congruence between icon shape and sensory expectations was manipulated and the participants had to categorise the eight bags of nuts used as stimuli as being spicy or roasted. Following our hypothesis, the congruent pairings were angular icons with spiciness and rounded icons with roasted flavour, while the incongruent pairings were rounded icons with spiciness and angular icons with roasted flavour. From now on, these pairings will be referred to as *Angular/Spicy*, *Rounded/Roasted*, *Rounded/Spicy* and *Angular/Roasted*, respectively.

At the beginning of each block, a screen with instructions was displayed indicating how the stimuli should be classified in the upcoming trials. Throughout each block, the target stimuli appeared (one at a time) in the centre of the screen and the words *Spicy* and *Roasted* remained visible to the left or right of the target stimulus. The participants had to respond as fast and accurately as possible by pressing the E or the I keys on the keyboard according to the correct mapping indicated in the block's instructions. If participants made an error, feedback of a red cross on the screen was shown during 500 ms. The right-left position of *Spicy* and R*oasted* words was counterbalanced between blocks, thus generating four randomly ordered different blocks of trials. Each block consisted of 16 randomly ordered trials (with each stimulus repeated twice), giving rise to a total of 64 trials completed by each participant (Table 2). Block order was randomised across participants. The task was preceded by a set of 16 practice trials which were not analysed in order to familiarize participants with the procedure. The reaction times (RTs) of participants' responses were collected.

Table 2

Summary of the blocks of the speeded classification task

Block	Congruence	Left response key	Right response key	Number of trials
1	Congruent pairings	Angular/Spicy	Rounded/Roasted	16
2	Reversed congruent pairings	Rounded/Roasted	Angular/Spicy	16
3	Incongruent pairings	Angular/Roasted	Rounded/Spicy	16
4	Reversed incongruent pairings	Rounded/Spicy	Angular/Roasted	16

The implicit sensory associations for each set of fire icons (angular or rounded) was operationalized as Cohen's d_z standardized difference scores (Cohen, 1988, p. 48; cf. Lakens, 2013). Thus, Cohen's d_z score was calculated for the angular set of icons as the mean of the differences between the RTs of the *Angular/Spicy* and the *Angular/Roasted* trials divided by the standard deviation of those differences, while for the rounded set of icons it was calculated as the mean of the differences between the RTs of the *Rounded/Spicy* and the *Rounded/Roasted* trials divided by the standard deviation of those differences. By doing so, the lower the negative value, or the larger the positive value, the stronger the association with spiciness or roasted flavour, respectively. Note that these Cohen's d_z scores represent a measure of implicit expectations as they were calculated by using the RTs obtained in the speeded classification task, and that the participants were not explicitly asked about their sensory expectations.

4.5. Data analyses

Regarding the association between spiciness and shape angularity, a one sample t-test was conducted for each scale (spiciness and roasted flavour) with zero (the mid-point of the scale) as the test value in order to assess if there was a statistically significant association to one of the shapes of the scale. Additionally, a paired measures t-test was used to compare the position of each stimulus on the scale in order to verify that both were sufficiently different from each other. A chi-square in contingency tables was used to analyse the results of the matching task.

As for the speeded classification task, the RTs of the incorrect trials (i.e. wrong answers, 6.46% of the responses) or which deviated by more than 3 standard deviations from the participants' conditional mean (2.43% of the correct answers) were excluded from the analyses (Semin & Palma, 2014). Remaining data were first analysed in a 2 x 2 repeated measures ANOVA with the shape of the fire icons (angular, rounded) and expectations (spicy, roasted) as the two factors and the mean reaction time (RT) required to classify each nuts bag as the dependent variable. The aim of this preliminary analysis was to check if an interaction existed so that the mean RTs of each of the four combinations of trials (i.e. *Angular/Spicy*, *Rounded/Roasted*, *Rounded/Spicy* and *Angular/Roasted*) could be analysed separately. Once that condition was fulfilled and the Cohen's d_z scores had been calculated for both the angular and the rounded set of icons, a paired measures t-test was used to compare them in order to assess if sensory expectations were influenced by the fire icons shapes.

Finally, a mediation analysis was conducted to investigate whether the effect of the icons' shape on sensory expectations was mediated by the perceived aggressiveness of the icons. Mediation analysis is a regression-based statistical method used to evaluate if an independent variable influences a dependent variable through one or more other intervening variables (Hayes, 2009, 2018). In its simplest form, a simple mediation model is a causal system in which an independent variable X is proposed to influence a dependent variable Y through a single mediating variable M, thus allowing to assess the mechanism by which X exerts its effect on Y (Hayes, 2018). According to our proposed model, an angular fire icon is considered more aggressive than a rounded fire icon, which in turn raises spiciness (vs roasted flavour) expectations (being the opposite true for a rounded fire icon). Hence, the shape of the fire icons (angular or rounded) was used as the two-condition independent variable, the Cohen's d_z score was used as the dependent variable, and the mean perceived aggressiveness of each fire icon set was used as the mediating variable. The analysis was carried out using the MEMORE 1.1 macro for SPSS according to the method proposed for within-subject experimental designs by Montoya & Hayes (2017). MEMORE is a macro for SPSS which allows to easily implement the method described by Judd, Kenny, & McClelland (2001) by which mediation analysis should be conducted in within-subject designs. Bias-corrected bootstrapping (5000 samples) was used to calculate confidence intervals for the indirect effect.

Effects for the t-tests and the ANOVA were considered statistically significant when $p<0.05$. The indirect effect of the mediation analysis was considered significant if it did not include zero (Montoya & Hayes, 2017). Effect sizes for paired measures t tests were operationalized as Cohen's d_z standardized difference scores (Cohen, 1988, p. 48). The data was processed and analysed by using SPSS Statistics 23 (Armonk, NY, USA).

5. Results

5.1. Association between spiciness and shape angularity

An association exists between spiciness and angularity, as the participants judged spiciness as having a significantly pointy shape, X□=-3.75 cm, $t(65)=-37.16$, $p<0.001$, supporting H1a. In contrast, roasted flavour was not found to be associated neither with the angular shape nor with the rounded shape, X□=0.09 cm, $t(65)=0.37$, $p=0.71$. Thus, both stimulus were located on the scale in places significantly different from each other, $t(65)=15.32$, $p<0.001$, $d_z=1.89$ (Fig. 5).

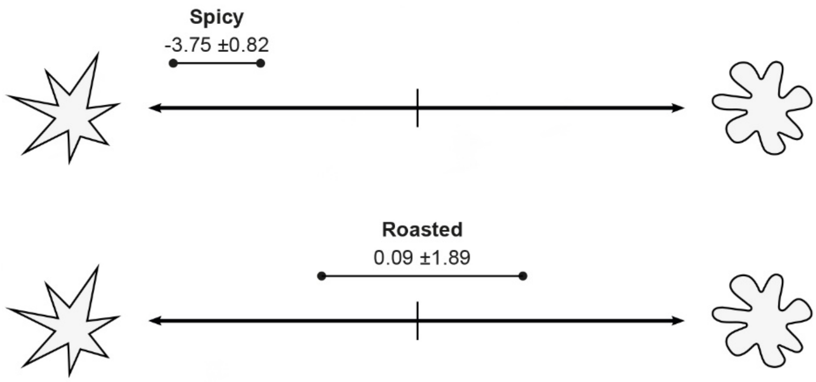

Fig. 5. Results of the association between spiciness/roasted flavour and shape angularity. Each scale was 10 cm long. The vertical lines represent the mid-point of the scales. The participants' mean response ± the standard deviation (SD) for each stimulus are represented above the scales.

The results of the matching task reinforce these findings and show that the angular shape is robustly matched with spiciness and, as a result, the rounded shape is matched with the roasted flavour (angular/spicy and rounded/roasted matches, respectively: N=63, 95.4%; $\chi^2 = 54.545$, $p<0.001$). These findings suggest that while the roasted flavour is not associated with any particular shape when assessed by itself, it is consistently paired with the rounded shape in a matching task due to the strong association that exists between spiciness and angular shapes.

5.2. Effect of the shape angularity of the fire icons on sensory expectations

The results of the 2x2 repeated measures ANOVA show that the interaction between the shape of the fire icons and sensory expectations was significant, $F(1,65)=27.44$, $p<0.001$, $\eta^2_p=0.30$, so the four combinations of trials (i.e. *Angular/Spicy*, *Rounded/Roasted*, *Rounded/Spicy* and *Angular/Roasted*) were analysed separately. As can be seen in Table 3, participants classified the angular fire icons significantly faster when they were associated with spiciness than when they were associated with the roasted flavour, $t(65)=4.84$, $p<0.001$, $d_z=0.59$. Furthermore, participants classified the rounded fire icons significantly faster when they were associated with the roasted flavour than when they were associated with spiciness, $t(65)=-4.21$, $p<0.001$, $d_z=-0.52$. No differences were found within the congruent pairing, $t(65)=-0.63$, $p=0.53$, $d_z=-0.08$, nor within the incongruent pairing, $t(65)=-0.63$, $p=0.53$, $d_z=-0.08$.

The shape angularity of the fire icons exerted an influence on sensory expectations, as the nuts' bags which displayed angular fire icons were associated with spiciness (Cohen's $d_z=-0.57$), and the nuts' bags with rounded fire icons were conversely associated with the roasted flavour (Cohen's d_z=0.42), t(65)=4.66, p<0.001, d_z=0.57, supporting H1b.

Table 3

Mean RTs obtained in the speeded classification task

Fire icons shape	Mean RTs in ms (SD)		Cohen's d_z
	Spicy	Roasted	
Angular	512 (79)	574 (127)	-0.57
Rounded	567 (147)	507 (74)	0.42

5.3. Indirect effect of the shape angularity of the fire icons on sensory expectations through the fire icons' perceived aggressiveness

The results of the mediation analysis show that the fire icons' angularity indirectly influenced sensory expectations through its effect on how aggressive the fire icons' were perceived (Fig. 6), thus supporting H2. The indirect effect of the fire icons' shape on sensory expectations through the icons' perceived aggressiveness was statistically significant, with the 95% not containing zero (Bootstrap [5000] results: B=-0.91, SE=0.35, 95% CI [-1.56, -0.19]). The participants considered the angular fire icons as more aggressive than the rounded fire icons (B=2.61, SE=0.15, p<0.001), which in turn increased the expectations that the product was spicy rather than roasted (B=-0.35, SE=0.17, p<0.05). The direct effect of the fire icons' shape on sensory expectations was not significant (B=-0.08, SE=0.50, p=0.88), suggesting that there was no evidence that the shape of the fire icons had an effect on sensory expectations regardless of its aggressiveness perception (Hayes, 2018).

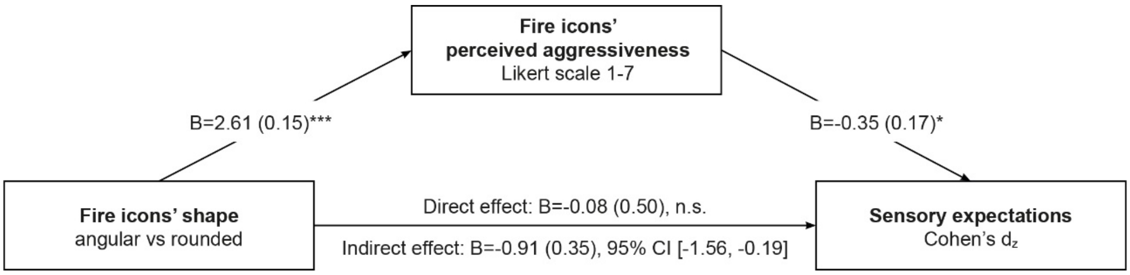

Fig. 6. Mediation of fire icons' perceived aggressiveness between fire icon's shape and sensory expectations (MEMORE 1.1, number of bootstraps=5000; Montoya & Hayes, 2017). *Note:* Negative values in the dependent variable represent a stronger association with spiciness rather than with roasted flavour, while the opposite is true for positive values. Coding=angular (1), rounded (0); B (SE)=path coefficient (standard error); *p < 0.05, **p < 0.01, ***p < 0.001.

6. Discussion

This research assessed if the crossmodal correspondence between spiciness and shapes could be used to modulate how people interpret an ambiguous image depicted on food packaging. To that end, the association between spiciness and angular shapes was studied, and a response time-based experiment was conducted on which it was assessed if the spiciness expectations of a bag of nuts could be enhanced by manipulating the angularity of a fire icon depicted on its front. The results indicate that the packages displaying angular fire icons enhanced spiciness expectations, whereas the packages with rounded fire icons were more easily associated with the roasted flavour. This influence was mediated by the perceived aggressiveness of the icons, so that a pointy fire icon raised spiciness expectations through a higher aggressiveness perception.

This investigation can be framed in the literature related to the influence of visual extrinsic cues on consumer expectations and response to food, where the effect of factors such as packaging shape (Becker et al., 2011; Overbeeke & Peters, 1991; Rebollar, Lidón, Serrano, Martín, & Fernández, 2012; Smets & Overbeeke, 1995), packaging colours (Piqueras-Fiszman & Spence, 2011; Spence, 2018; Tijssen, Zandstra, de Graaf, & Jager, 2017) or packaging images (Lidón, Rebollar, Gil-Pérez, Martín, & Vicente-Villardón, in press; Rebollar et al., 2016, 2017; Smith et al., 2015; Szocs & Lefebvre, 2016) has been analysed (see Piqueras-Fiszman & Spence, 2015; and Velasco, Woods, Petit, et al., 2016, for reviews). As we will discuss here, the findings of this research contribute to the literature in two ways. First, these results go a step further in the field of crossmodal correspondences by documenting an association between spiciness and pointy shapes and suggesting that it is mediated through affective evaluation. Second, we show that these findings can be implemented in the field of semiotics in order to help packaging designers and producers to convey the right messages to the consumer, as one of the possible interpretations of an image displayed on a packaging may be favoured by manipulating the image's shape.

The results of this study contribute to the research of crossmodal correspondences showing that an association exists between spiciness and pointy shapes. Although this association had never been empirically tested before, there were grounds to think that pointy shapes and spiciness may be matched in consumers' mind (Blazhenkova & Kumar, 2018; Wang et al., 2017). Indeed, this result is in line with previous studies that have documented associations between spiciness and cues from other sensory domains such as audition (Wang et al., 2017) or sight (Levitan & Shermer, 2014; Tu et al., 2016). For example, Seo et al. (2010) demonstrated that the smell of pepper (which, according to Wang et al, (2017), is an approximate olfactory counterpart to the trigeminal spicy sensation) is more associated with angular shapes rather than with rounded shapes. Given that olfaction plays a key role in the perception of flavour (Spence, Smith, & Auvray, 2014; Spence, 2015), it is not surprising that this association also occurs when thinking about other flavour contributors such as the burning sensation caused by capsaicin (Lawless, 1989; Charles Spence, 2015b). In this regard, it may be argued that this association could have been driven based either on trigeminal cues or aromas, as the term *spiciness* may refer to both. Spiciness is a sensation that can contribute to flavour perception (Lawless, 1989; Spence, 2015b). *Spicy* may be sometimes, and for some, equivalent to painful, warm, irritating, burning (Bègue et al., 2015; Caterina et al., 1997). One may think that since in our main study there were two types of shapes and two sensory descriptors, the correspondence could have been driven based either on trigeminal cues or aromas. However, we propose that the correspondence is more trigeminal-based since spiciness was highly associated with the angular shape, but the roasted flavour (when assessed by itself) was not particularly associated to a shape. In addition, the fact that the effect was mediated by aggressiveness supports the notion that the difference is more based on trigeminal associations, since the concept of "roasted aroma" in this food context cannot be painful (nor linked to aggressiveness).

Furthermore, our results indicate that the association between spiciness and pointy shapes is affectively mediated, since perceived aggressiveness of the icons designed to convey sensory information increased spiciness expectations. This supports the notion that crossmodal correspondences between flavours and shapes may be, at least to some extent, explained in terms of affective mediation (Guerdoux et al., 2014; Palmer et al., 2013; Schifferstein & Tanudjaja, 2004), and is in line with previous findings that suggest that both pointy shapes and spiciness share a common affective space in which both stimuli are rendered as unpleasant or aggressive: whilst pointy shapes are generally associated with dangerous objects (Ghoshal et al., 2015) or even angry faces (Aronoff et al., 1992) and therefore are initially disliked in comparison with rounded shapes (Bar & Neta, 2006), the burning trigeminal sensation produced by the capsaicin of spicy food has been related to discomfort, unpleasantness or pain (Bègue et al., 2015; Byrnes & Hayes, 2013; Caterina et al., 1997). Thus, the results of this research add to those of other studies which suggest that the mechanism behind the crossmodal correspondence between flavour and shapes is of an affective nature and do not fit satisfactorily into any of the three kinds of crossmodal correspondences previously proposed in the literature (i.e. statistical, structural or semantic; Spence, 2011). Indeed, the studies that have assessed separately the association between abstract shapes and each of the sensory components of flavour perception (i.e. taste, smell or trigeminal; Spence et al., 2014) appear to be in the same line, as is the case with taste-shape correspondences (Liang et al., 2013; Velasco et al., 2015), odour-shape correspondences (Hanson-Vaux et al., 2013; Seo et al., 2010) or trigeminal-shape correspondences (Spence et al., 2014): the mechanism behind these correspondences seems to work indirectly through emotion rather than through environmental or language inferences (cf. Turoman, Velasco, Chen, Huang, & Spence, 2018). However, note that it seems unlikely that the association between spiciness and pointy shapes is exclusively mediated by an affective evaluation: although the evidence suggesting that affective judgements play an important role in the matching between different stimuli across the senses related to flavour perception is strong, other still unknown mechanisms may also be at play (Turoman et al., 2018). In this regard, both the literature on shapes and motivation (Velasco, Salgado-Montejo, et al., 2016) and the literature on embodiment and grounded cognition (Salgado-Montejo, Tapia Leon, Elliot, Salgado, & Spence, 2015; Te Vaarwerk, van Rompay, & Okken, 2015) may offer alternative explanations for the findings reported here. While the shapes and motivation approach argues that people tend to avoid negatively-valenced stimuli and to approach positively-valenced stimuli (Krieglmeyer, Deutsch, de Houwer, & de Raedt, 2010; although the association between angular shapes and approach/avoidance motivation is yet not completely understood, e.g. Palumbo, Ruta, & Bertamini, 2015; Velasco, Salgado-Montejo, et al., 2016), embodiment assumes that people interpret abstract concepts in terms of everyday physical interactions (Lakoff & Johnson, 1999). As stated by Fenko & van Rompay (2018), embodied cognition commonly assumes that the representation of symbolic concepts is grounded in direct bodily experience with the physical world. For example, abstract concepts like *importance* and *dominance* are processed in terms of physical properties such as *weight* and *height*, as people tend to relate the heaviness of an object and its perceived importance (Jostmann, Lakens, & Schubert, 2009) or the relative height of a product and its perceived dominance (van Rompay, Hekkert, Saakes, & Russo, 2005). Thus, according to this approach the association between spiciness and pointy shapes could also be explained because both concepts are structured under a similar underlying schema (van Rompay, Hekkert, & Muller, 2005): Since early childhood we learn that physical and tactile interactions with angular objects may produce harm or pain on our skin, in the same way as spicy food may produce a similar sensation inside the mouth (Bègue et al., 2015; Caterina et al., 1997). Furthermore, it is worth mentioning that while aggressiveness is commonly related to threat and is thus initially disliked (Berkowitz, 1990; Liu, 2004), that does not necessarily mean that it will be always processed as a negative input (Landwehr, McGill, & Herrmann, 2011). As is the case with other initially disliked stimuli as angular shapes or bitter flavours, in some contexts the concept of aggressiveness may be linked to positive judgements and therefore may be rendered as positive (Ghoshal et al., 2015; Landwehr et al., 2011).

From a semiotic point of view, the main contribution of this paper is that it shows that when it comes to convey sensory information about a product though an image depicted on its packaging, the reported crossmodal correspondence between spiciness and shapes can be used to favour one of the image's possible interpretations. Although this possibility has been somewhat suggested by previous researchers (Ngo et al., 2012; Velasco, Woods, Petit, et al., 2016), this is the first study that specifically addresses it experimentally by manipulating the shape of an image depicted on a package. This finding can be framed on both the two lines of analysis proposed in the literature that seek to understand the factors by which an indeterminate stimulus evokes a particular meaning: the slot/filler approach and the analogy approach (Smith et al., 2015). The slot/filler approach assumes that the probabilities of opting for one of the possible meanings of the sign (filler) will be greater the better it fits with any of the possible attributes of the object (slot) (Fillmore & Baker, 2010; Lynott & Connell, 2010; Smith, Osherson, Rips, & Keane, 1988), while the analogy approach states that the interpretation that has proved valid in similar past combinations will be preferred (Estes & Jones, 2006; Gagné & Spalding, 2006; van Jaarsveld, Coolen, & Schreuder, 1994; see also Gregan-Paxton & John, 1997). The results of this investigation show that the shape of the image plays a role in these mechanisms, as it helps to evoke meaning by making a certain association more accessible in the mind of the consumer. Thus, according to the slot/filler approach, the results of this experiment can be explained as that an angular fire icon is associated with spiciness through an affective mechanism, so the concept *spicy* becomes more accessible to the consumer and therefore the chances of choosing it are increased. In addition, the existence of a crossmodal correspondence between spiciness and angular shapes implies that these results can also be explained under the analogy approach, since both spicy and pointy stimulus are consistently paired in consumers' mind as a congruent match. Overall, these findings show that when it comes to convey spiciness information about a product, images' shape angularity may be used besides other well-known signs such as textual claims or graphical scales (like the chillies scales commonly used in food packaging, where the higher the number of chillies shown, the spicier the food is supposed to be). Indeed, given the influence of sign congruency on consumer attitude (Becker et al., 2011), designers should be careful to ensure that all signs on the packaging send a consistent message.

However, as is the case in other works related to the study of crossmodal correspondences, the question arises as to what extent it is an association produced automatically in the mind of the consumer or, on the contrary, it rather emanates from a strategic process (Spence & Deroy, 2013). Some authors warn of the need to quantify the degree of automatism of the correspondences instead of adopting a two-pronged approach between bottom-up and top-down processes (Getz & Kubovy, 2018), and highlight the lack of consensus regarding what characteristics a process should have in order to be considered automatic (Spence & Deroy, 2013). Although conducting a speeded classification task allows to minimize the degree of reasoned processing (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009), it is important to be cautious when drawing conclusions about the true nature of this correspondence since it has been shown that a lot of processes occur in the milliseconds in which the participant takes time to respond (Fiebelkorn, Foxe, & Molholm, 2010; Horowitz, Wolfe, Alvarez, Cohen, & Kuzmova, 2009; Spence & Deroy, 2013) and recent research has suggested that crossmodal correspondences may not be absolute in nature and may rather be subjected to the specific configuration of the task (Brunetti, Indraccolo, Gatto, & Spence, 2017).

Beyond its contributions, this study has some limitations that must be taken into account. For example, there may be a bias regarding the diversity and features of the participants. Sample size was modest and all participants were university students living in the same country (Spain); as a result, further testing would be needed to see if these results could be extrapolated to other markets and other cohorts of consumers. In this regard, note that although some studies have found differences among populations (Bremner et al., 2013), crossmodal correspondences are shared by a large number of people (Spence, 2011). Indeed, few studies have been conducted to date studying individual differences (Parise, 2016). However, one may wonder if the semantic interpretation of the symbols displayed on product packaging would be different regarding consumer's culture and language, given that some studies suggest that structural differences between languages based on ideographic writing systems (e.g. Chinese) and western languages may influence packaging perception (Hoon Ang, 1997; Schmitt, Pan, & Tavassoli, 1994). A similar question arises regarding not only how people interpret symbols according to the structure of their language, but also according to their culture. Whereas for the participants in this study the depiction of an icon of fire in the context of food elicited the meaning of spiciness, this may not be the case across different cultures or consumer cohorts. Although the metaphor *spicy food is fire* relays on a sensation emerging directly from the sensory domain (Caterina et al., 1997; Tu et al., 2016), and may therefore be considered more stable across cultures than other kind of metaphors (e.g. linguistic metaphors, Landau, Meier, & Keefer, 2010), previous studies have suggested that the existence of individual differences should not be disregarded even within the same cultural group (Piqueras-fiszman, Ares, & Varela, 2011).

Moreover, although in this type of study it is very difficult to completely isolate the study variable and there is a risk that part of the effects reported here are not exclusively due to the angularity of the icons but to another factor, the icons were designed as similar as possible in terms of size, symmetry and colour (Parise, 2016). Despite this, it could be argued that they are not only differentiated by angularity but also by other factors such as complexity, symmetry or colour, which in turn could have influenced the results (Turoman et al., 2018). Therefore, it cannot be ruled out that other factors besides angularity may have had an effect on the findings reported in this study, which leaves the door open to further research. On the other hand, despite the fact that participants did not know the true aim of the study, it should be noted that the order of the different experiment parts may have primed the responses for the subsequent tasks by making some concepts (namely, aggressiveness) more accessible in participants' minds. Priming is said to occur when one stimulus affects how a subsequent stimulus is processed (Johnston & Dark, 1986), so asking the participants to rate the perceived aggressiveness of each of the fire icons used as stimuli in the speeded classification task may have biased their responses. To prevent this, the participants had also to evaluate each fire icon with respect to three other concepts not related to the objectives of the study (which were used as distractors). However, despite this precaution, the presence of a priming effect cannot be completely ruled out. Furthermore, the crossmodal association between spiciness and angular shapes was studied by using the spicy word and not by tasting spicy samples of food. Further research is thus needed in order to assess if this correspondence also occurs with tastants and not only with words (Velasco, Woods, Marks, et al., 2016).

The work presented in this paper can be further developed through future lines of research. For example, this study did not analyse the effect of the fire icons shape on consumer affective response. It would be reasonable to expect that a higher perceived aggressiveness would lead to a positive attitude towards the product for consumers who like spicy food, while the opposite would be expected for people who does not like the burning sensation produced by pungent food. It would also be interesting to assess how the findings reported here relate to other signs commonly used to indicate the degree of spiciness of a food, such as chillies scales: according to our findings, one might think that the manipulation of the chillies' shape may be used to modulate spiciness expectations conveyed by the scale. In addition, the scope of this research was limited to studying the effect of manipulating the shape of an icon of fire depicted on a package on consumer expectations. The next logical step would be to assess if the shape manipulation also has an effect on sensory perception and on the hedonic response to the product, as other studies in this field suggest (Becker et al., 2011; Velasco et al., 2015). Moreover, it should be taken into account that while in this paper spiciness has been treated as if it was a single stimulus, in reality there are many kinds of spiciness differentiated in their intensity, their duration, and in the location of the trigeminal system receptors that react in contact with capsaicin (Baron & Penfield, 1996; Caterina et al., 1997; Prescott & Stevenson, 1995). Therefore, a next study should consider these differences by analysing their effect on the crossmodal correspondence between spiciness and abstract shapes.

7. Conclusion

For the consumer, correctly interpreting the visual signs depicted on food packaging is key to set the right sensory expectations. However, since an image can evoke different meanings in a given context, it is not easy for the designer to anticipate how the consumer will interpret it. The results of this investigation shed light in this subject showing that designers can communicate sensory information about the product just by manipulating the shape of the images depicted on the packaging. Specifically, it shows that while it is possible to communicate that a bag of nuts is spicy through a pointy fire icon (since the consumer implicitly associates spiciness and pointy shapes because both stimuli are rendered as aggressive), if the same bag of nuts displays a rounded fire icon the consumer rather interprets that the product have been roasted. Overall, these findings suggest that if a designer has to convey that the product contained in a package is spicy, it may be a good idea to do so by depicting angular images or pointy shapes rather than by depicting rounded shapes. This paper thus shows a useful way to implement the theoretical advances made to date regarding the crossmodal correspondence between spiciness and abstract shapes. This is of great interest to producers and food packaging designers as it can help them to better communicate the desired message to consumers.

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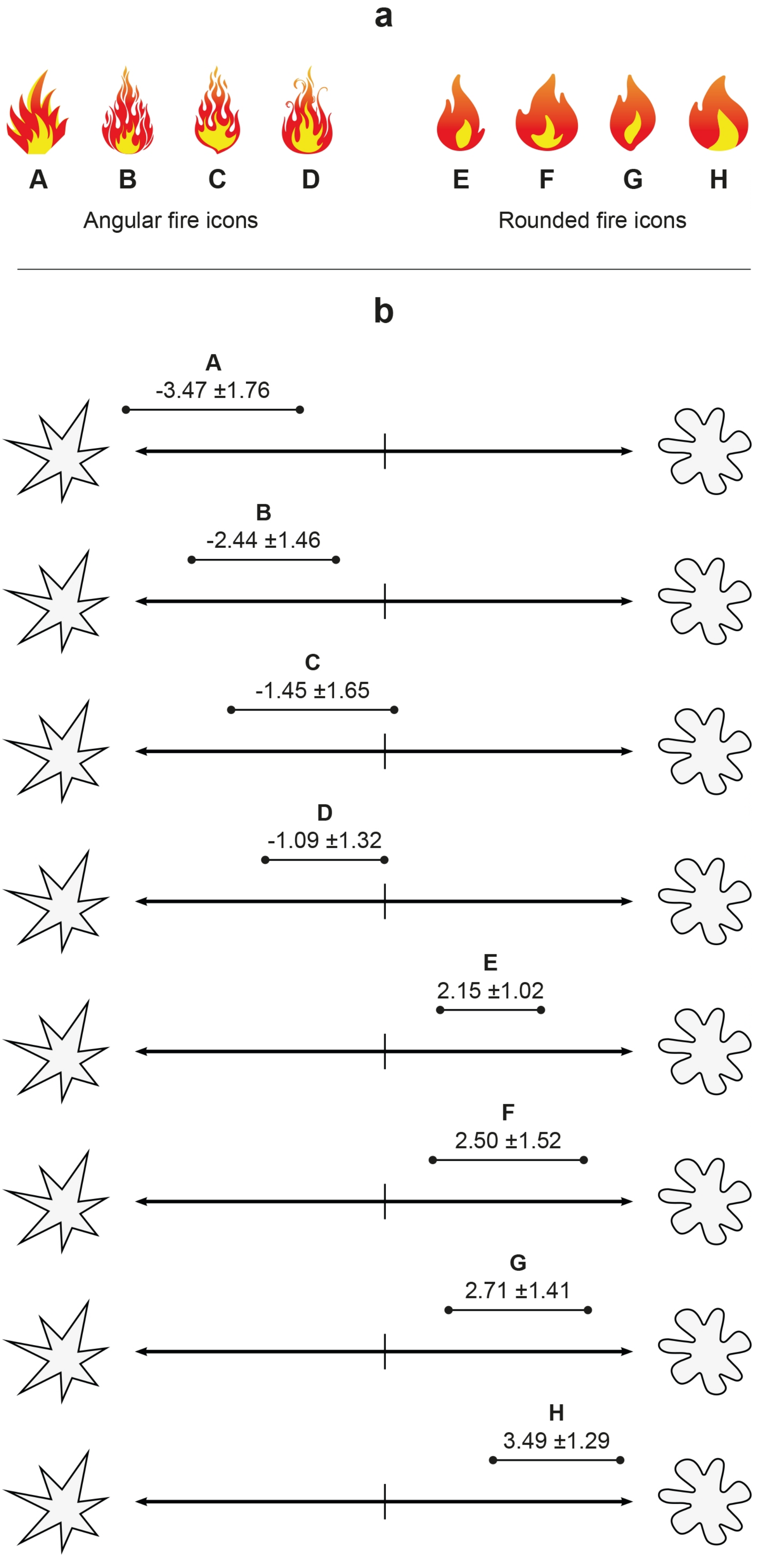
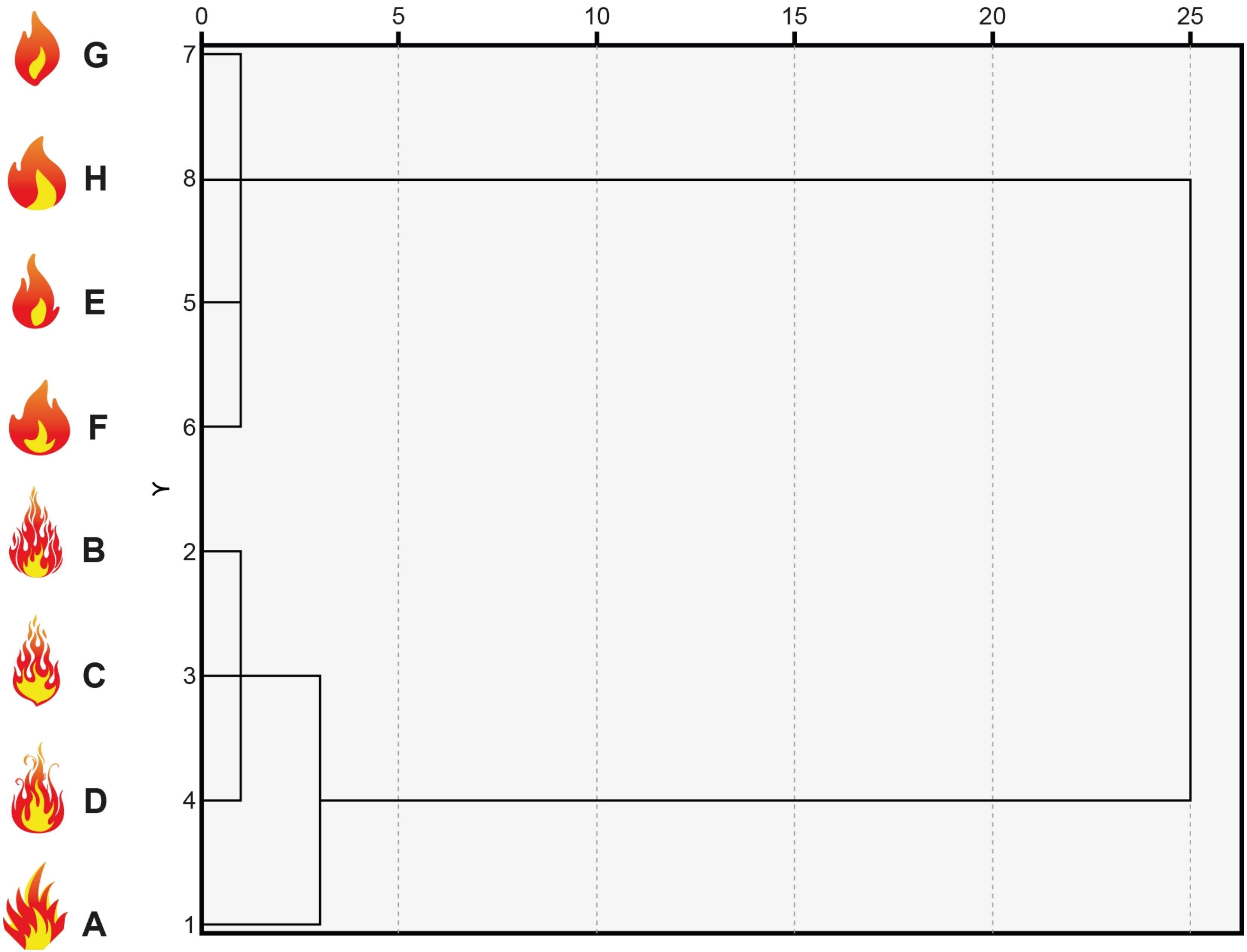
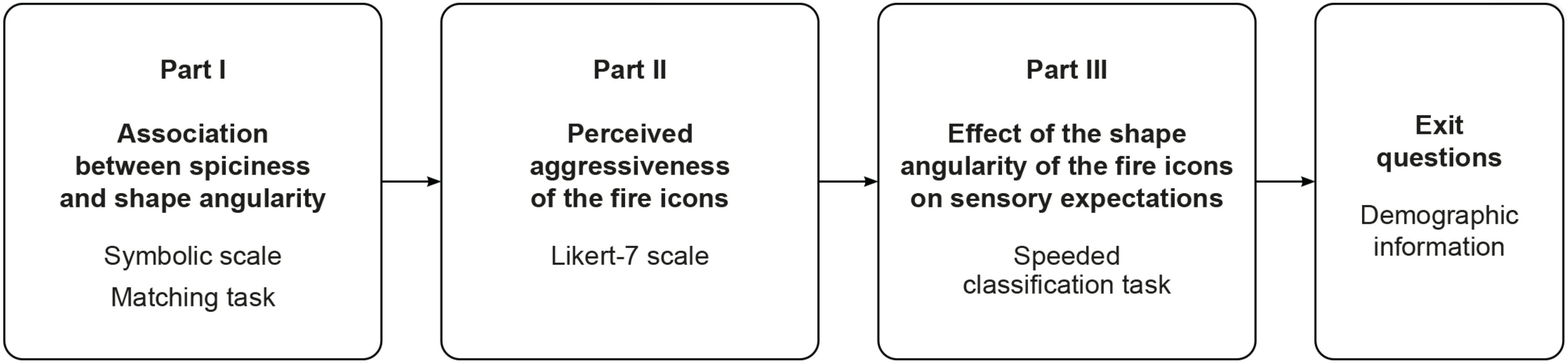

a
A
B
C
D
E
F
G
H
Angular fire icons
Rounded fire icons
b
A
-3.47 ±1.76
B
-2.44 ±1.46
C
-1.45 ±1.65
D
-1.09 ±1.32
E
2.15 ±1.02
F
2.50 ±1.52
G
2.71 ±1.41
H
3.49 ±1.29

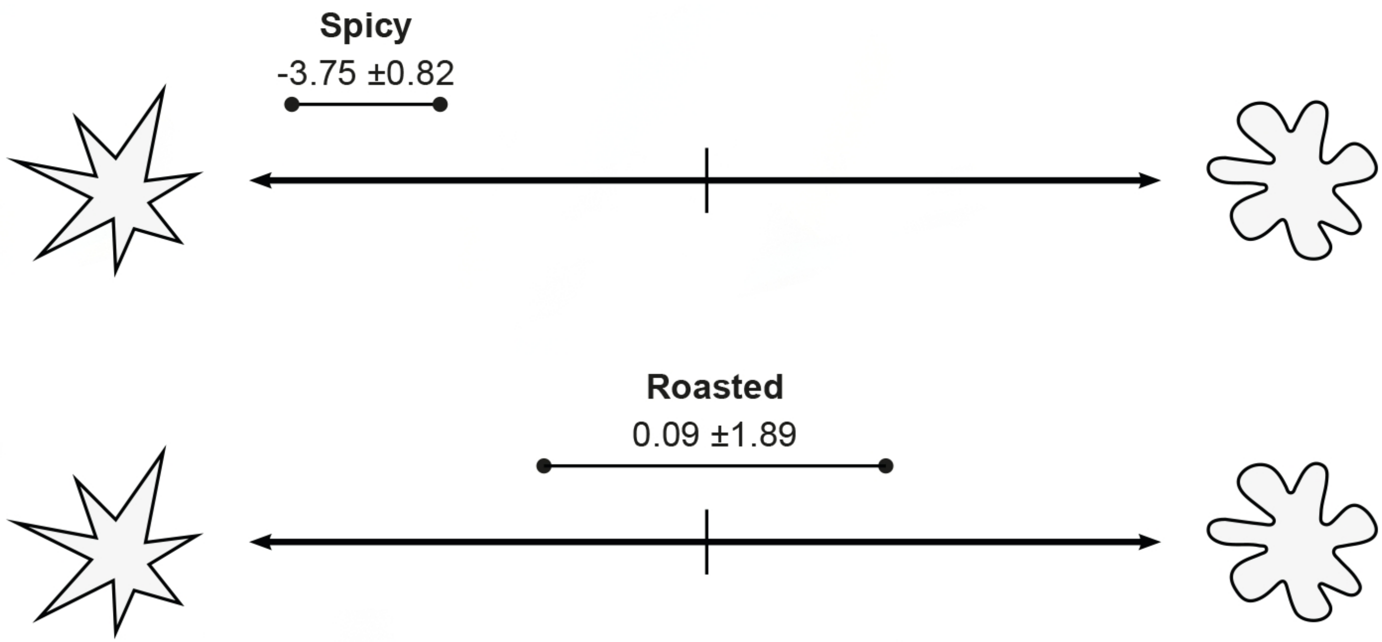


0
5
10
15
20
25
G
H
E
F
B
C
D
A
7
8
5
6
2
3
4
1
Y


FairField's
COCKTAIL
CACAHUETES Y MAÍZ


FairField's
COCKTAIL
CACAHUETES Y MAÍZ


Part I
Association between spiciness and shape angularity
Symbolic scale
Matching task
Part II
Perceived aggressiveness of the fire icons
Likert-7 scale
Part III
Effect of the shape angularity of the fire icons on sensory expectations
Speeded classification task
Exit questions
Demographic information


Spicy
-3.75 ±0.82
Roasted
0.09 ±1.89

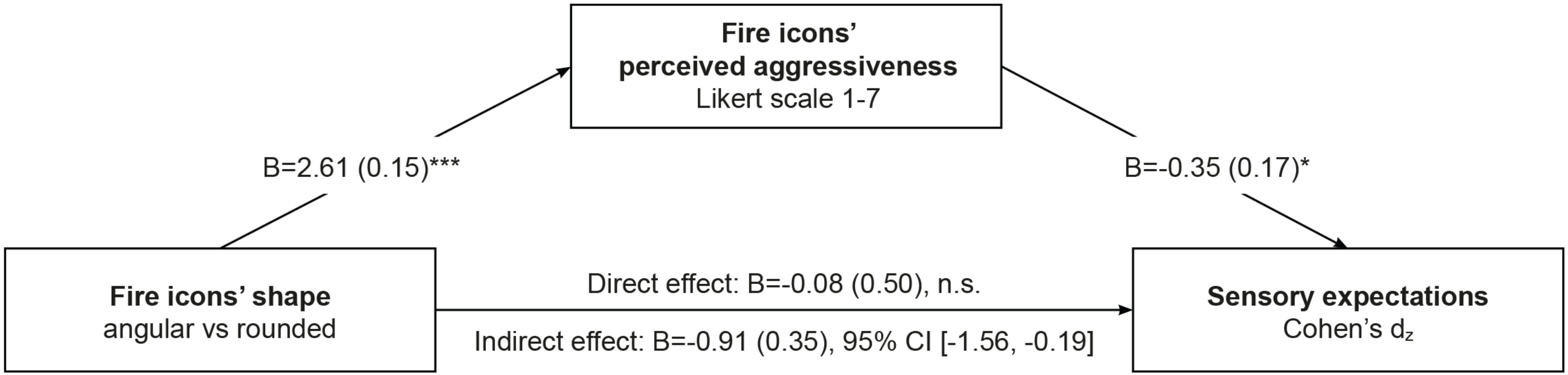

Fire icons'
perceived aggressiveness
Likert scale 1-7
B=2.61 (0.15)***
B=-0.35 (0.17)*
Fire icons' shape
angular vs rounded
Direct effect: B=-0.08 (0.50), n.s.
Indirect effect: B=-0.91 (0.35), 95% CI [-1.56, -0.19]
Sensory expectations
Cohen's d_z

Table 1

Ward's hierarchical cluster analysis

Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	G	H	31,585	0	0	4
2	E	F	74,675	0	0	4
3	B	C	126,690	0	0	5
4	E	G	192,418	2	1	7
5	B	D	263,756	3	0	6
6	A	B	443,602	0	5	7
7	A	E	2218,866	6	4	0

Table 2

Summary of the blocks of the speeded classification task

Block	Congruence	Left response key	Right response key	Number of trials
1	Congruent pairings	Angular/Spicy	Rounded/Roasted	16
2	Reversed congruent pairings	Rounded/Roasted	Angular/Spicy	16
3	Incongruent pairings	Angular/Roasted	Rounded/Spicy	16
4	Reversed incongruent pairings	Rounded/Spicy	Angular/Roasted	16

Table 3

Mean RTs obtained in the speeded classification task

Fire icons shape	Mean RTs in ms (SD)		Cohen's d_z
	Spicy	Roasted	
Angular	512 (79)	574 (127)	-0.57
Rounded	567 (147)	507 (74)	0.42