Universiteit Utrecht
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Promoting healthy food choice with a visual cue

The influence of manipulating simulation with a visual product extrinsic cue on sensory evaluation and liking of a food product.

Chantal Antheunisse (3994813)
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Supervision:
Prof. Dr. Monique Smeets
Aart van Stekelenburg, Msc
Dr. Marnix Naber

Abstract. **Moving consumers towards the choice of healthier reformulated food is challenging, as reformulated food and even reduced-salt labels generate a negative taste expectation and experience. However, it is known that if consumers merely perceive a visual of a food item, this can trigger simulations of consuming it, resulting into certain behaviour intentions and attitudes. Adopting a grounded cognition perspective, we suggest that showing a visual cue, congruent to the situated eating context of a food product (soup in a kitchen) leads to *more simulation* of the soup consumption experience, *more salivation*, *more liking* and a *different sensory evaluation*, compared to showing a visual cue, incongruent to the situated eating context (soup in a cinema). These hypotheses were tested in a between-subjects design with three conditions. In an experiment, simulation was manipulated by a visual cue (congruent, incongruent or control) and a tasting session was executed. As expected, a congruent visual leads to more simulation on aspects directly related to the food product itself, an increase in the amount of salivation, increased desire to eat the product and the expectation to like the product more, than an incongruent visual. Surprisingly, results do not indicate any direct or indirect effect (mediated by simulation) of congruence on liking of the food product or the sensory evaluation. These findings suggest that using simple unconscious visual cues can facilitate the choice of healthy food, but more research is needed on how these cues can also influence the taste experience itself.**

1. Introduction

Stimulating society to make healthier food choices is an essential issue as 15 percent of the women and 13 percent of the men, between the age of 30 to 70, were qualified as obese in the Netherlands in 2012 (van Berkel, 2016). Obesity is not only caused by people consuming more calories than people with a normal BMI, but obesity is also partly caused by an unbalanced diet with a high intake of fat and salt from daily consumption of savory foods (Campbell et all, 2011, van Berkel, 2016). It is believed that reduction in sodium (consumed as common salt) will help diminish health care costs, as high levels of sodium are associated with raised blood pressure, hypertension and adverse cardiovascular health (Brown et al., 2009). Therefore, international authorities such as the World Health Organisation feel that mandatory reduction in sodium level is needed and encourage the food industry to reduce sodium levels in their products (Dötsch et al., 2009). A common strategy to reduce the amount of salt in foods is to replace sodium by salts boosters or replacers. Nevertheless, a 40% replacement of salt can already cause an unacceptable off-taste and boosters can induce other undesired savoury notes (Busch et al., 2013; Charlton et al., 2007).

So, the main challenge is to ensure that the reformulated food stays acceptable to the consumer and the people will still choose this healthier food. To make the consumer aware of the decrease of salt in the product, reduced-salt labels are commonly used. Yet, these labels generate a negative taste expectation and actual taste experience, in terms of liking and perceived saltiness. Consumers even added extra salt when soups carried the reduced-salt label (Liem et al., 2012). Besides this, multiple studies demonstrate that many consumers today shop under high levels of perceived time pressure and buy a product in an impulse without even reading the nutrition label (Hausman, 2000, as described in Silayoi & Speece, 2004). So research will need to have a look at how cues, that are not physically part of the food, can unconsciously influence taste perception and move the consumer towards the choice of this healthier reformulated food. We know that if consumers merely perceive a picture of a food item, this can trigger spontaneous simulations of eating it, including thinking about the pleasure of eating the food (Papies, 2013). Therefore, this research will consider how visual cues, that are not physically part of a food product, influence taste perception in an unconscious way and how mental simulation plays a part in this process.

This research article will begin by establishing a theoretical foundation for our hypothesized effects, with a review of relevant literature on flavour perception, product extrinsic cues and mental simulation. An explanation of our experiment that tests these hypotheses will follow. At the end of this article, our results will be concluded with addressing specific contributions of this research, as well as by presenting future research directions in this area.

1.1. Taste perception and extrinsic cues

Taste and flavour perception are unique for each person and depend on many variables. 'Taste perception' can be seen as perception based on the five senses in our mouth (bitterness, saltiness, sourness, sweetness and umami). However, in this research, we will focus on 'flavour perception', which is more a multisensory perception with inputs from many other sensory modalities beside our five mouth senses, like the food odour and mouthfeel. On the one hand, flavour perception can be influenced by individual differences in the taste sensory system, due to the genetic background and taste receptors make up. On the other hand, flavour perception can be influenced by the appearance of the food, the environment in which the food is presented or other product intrinsic and extrinsic cues (Okamoto & Dan, 2013). Product *intrinsic* cues are those cues belonging to the product itself, so these cues cannot be changed without changing the product itself (for example the smell or colour of a food). *Extrinsic* cues are those cues that are somehow related to the product, but not physically a part of it, such as a product labeling, packaging, shop-floor location and other types of marketing communications (Spence & Piqueras-Fiszman, 2014).

As explained in the introduction, more focus is needed on the effect of extrinsic cues on the perception of flavour. Previous research shows that a simple linguistic extrinsic cue can already have an impact on the sensory perception and liking of a food product. Shankar, Levitan, Prescott and Spence (2009) demonstrated that people rate M&M's as tasting more chocolatey when they are simply labelled as 'dark' chocolate instead of 'milk' chocolate. Also, visual extrinsic cues, which will be used in this research as well, seem to influence flavour perception. A study by Underwood and Klein (2002) demonstrated that consumers rate a product as significantly tasting better when containing a packaging image, instead of the product without a packaging image. But also the kind of picture, pleasant/unpleasant orange pictures on juice packages, can influence flavour evaluation. Juices presented with pleasant orange pictures are rated as more palatable and fresh (Mizutani et al., 2010).

1.2. Mental simulation

Within this research, we focus on *'simulation'* as the underlying mechanism for the effect of extrinsic cues on flavour perception. Simulation is introduced in 'the theory of grounded cognition'. This theory proposes that when people conceptualize something in their minds, they don't conceptualize it in an isolated and abstract way, but in a situated way (*situated conceptualization)* (Papies & Barsalou, 2015). People will conceptualize 'tomato soup' in a particular setting (e.g. in a bowl in the kitchen) and adopt a cognitive perspective towards it (e.g. eating soup in the winter time). Besides including settings and cognitive perspectives, situated conceptualizations represents the object in a context-appropriate manner as well. The tomato soup will be represented in a specific type of context congruent to a situation for that type of tomato soup, for example, hot tomato soup with meat in a cold winter time.

When someone experiences eating soup, our brains will process all the different elements regarding this situated conceptualization of the soup with multiple modalities. For instance, our brain will process the soup in the environment (with the ventral system) and it will process the spoon-movement while eating the soup (motor behaviour), as well as someone's rewarding response to eating the soup (cognitive, affective and interceptive states and responses). This situated conceptualization can be seen as a conceptualization including all situational elements; a multimodal representation of the situation (Papies & Barsalou, 2015).

Another key assumption in this approach is that once a situated conceptualization has been retrieved, only one situational element of eating the soup (which can be any extrinsic cue) can trigger various other elements of the situated conceptualization. This process is referred to as pattern completion (Papies & Barsalou, 2015). If you go to the store and see a can with a picture of tomato soup, it can not only reactivate the mouthfeel of the structure of the soup, but also the pleasure associated with the warm feeling of eating the soup with your family on a cold Christmas day.

So, after eating soup, all the elements of our soup-eating experience are stored in our memory. After eating many kinds of soup, a network of soup-related memories is established and this will be our representation of the holistic ‘soup’ category. Once this network is created, it can always be used to interpret another category related situation. Now, when a new soup or any soup related cue will be represented to a person, this network can be activated and can produce the same kind of brain state (the simulation) as when the other kind of soup from the past was experienced. This simulation utilizes the same core eating network as eating itself (Chen et al., 2016) and especially when using attractive food, it can even induce salivation. This salivation will effectively prepare the body for eating the food (Keesman et al., 2016). An important side note to make is that the simulation doesn’t have to be an exact copy of the past experience, but sometimes can be biased and distorted. For example, when a new soup is tasted, a simulation of the whole soup category can be made, but also a simulation of specific features from the soup category.

1.3 Simulation manipulation

Supporting the ‘theory of grounded cognition’ it has been shown that a product-related extrinsic cue can be a trigger for a mental simulation. Giving certain extrinsic cues can even manipulate the simulation, which again affects product-related cognitions (Xie et al., 2006; Tucker & Ellis, 2001; Elder & Krishna, 2012). Simulation can be manipulated by giving specific cognitive instructions to the consumer, which can be seen as instructed simulation manipulation. An example of this is manipulating simulation by giving a verbal extrinsic cue like: ‘Imagine being away from all your misery, sitting on a tropical island under a palm tree and drinking this delicious juice’. This kind of simulation can have an effect on the attitudes and desires of a consumer (Xie et al., 2016).

Simulation can also be manipulated automatically as shown by Tucker and Ellis (1988). When participants had to judge whether a graspable object was in upright or inverted position, the response time was quicker when the handle of the object was in line with the hand of the response. So only seeing objects can automatically activate motor information on how to grasp them (Tucker & Ellis, 2001).

The research of Elder & Krishna (2012) also demonstrated that the way a product is visually displayed facilitates mental simulation, resulting into certain behaviour intentions. Using a subtle manipulation of orienting an object (a mug’s handle) towards a participant’s dominant hand can result into higher purchase intentions. The same works for displaying a piece of pie with a cake fork situated on the side of the dominant hand, which leads to a higher intention to eat the pie. However, when the dominant hand is occupied, the cake fork situated at the side of the non-dominant hand, leads to a higher eating intention. In other words, visually facilitating motor movements associated with a product and thereby manipulating the simulation of interacting with the object can result in different attitudes toward the product. Simulation influencing the real user’s intentions and product experience has been endorsed by Schlosser (2003), who also showed that simulation has a prominent role in affecting purchase intention. When people are estimating their own behaviour, they will first run a mental simulation of themselves performing that behaviour. If there is a congruency between the user’s mental simulation and the delivery of the product, this will influence discursive processing and thus their attitudes and behaviour.

This current study is part of the NUDGIS research project; Novel Understanding of Designs for Good Intervention Strategies in the food environment. A previous experiment which was done in this project likewise confirmed that manipulation of simulation can influence attitudes toward a product. In this experiment participants were presented two kind of visual product extrinsic cues; either an image consisting of a food product in a congruent eating context (soup in a kitchen), designed to elicit simulation of previous food-related experiences, or the food product in an incongruent eating context (soup in a cinema). The image of the congruent eating context, compared to the incongruent context, elicited a stronger simulation of the soup-eating experience, a stronger desire to eat the soup and the soup was expected to taste better. The effect of the image on desire and expected liking was partly mediated by the simulation of the soup-related aspects. The question remains whether this congruent and non-congruent visual product extrinsic cues will also affect the taste perception of the food product itself. Therefore, this research will be conducted to look at *the effect of simulation manipulation, via different visual product extrinsic cues, on sensory evaluation and liking of a food.*

It is expected that (see all hypothesis, with corresponding letters *'a, b, c, d & e'*, in *figure 1*):

a. Showing a visual product extrinsic cue, congruent to the situated eating context of the product, will lead to **more mental simulation** of the soup consumption experience, than showing a visual product extrinsic cue incongruent to the situated eating context.

b. Showing a visual product extrinsic cue, congruent to the situated eating context of the product, will also lead to **more salivation**, than showing a visual product extrinsic cue incongruent to the situated eating context.

c. Showing a visual product extrinsic cue, congruent to the situated eating context of the product, will lead to **more liking** of the product than showing a visual product extrinsic cue incongruent to the situated eating context.

d. Showing a visual product extrinsic cue, congruent to the situated eating context of the product, will lead to a **different sensory evaluation** of showing a visual product extrinsic cue incongruent to situated eating context.

e. The effect of the visual product extrinsic cue on sensory evaluation and liking of a food is **mediated by mental simulation.**

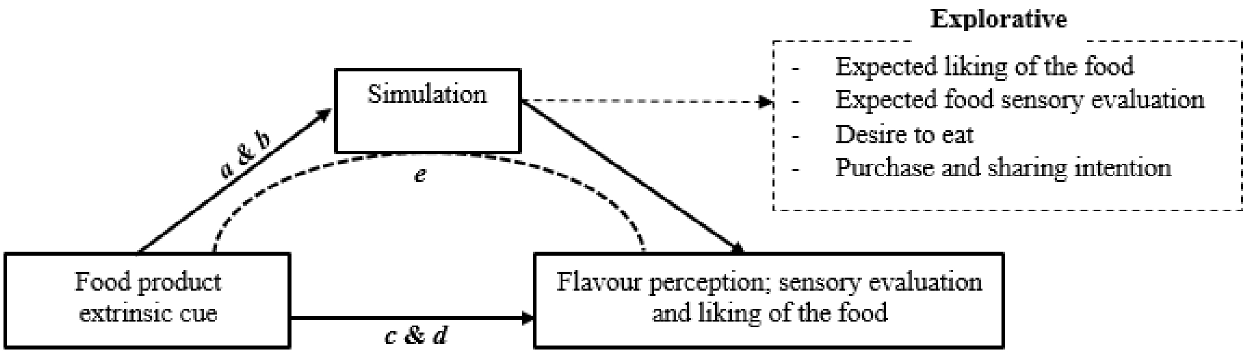

Figure 1. **We expect that, with reference to previous research, visual food product extrinsic cues that are congruent/incongruent to the eating context, can influence simulation differently and will lead to a difference in amount of salivation (*hypothesis a & b*). Also, these visual food-product related extrinsic cues will influence the liking of the food product and will lead to a different sensory evaluation (*hypothesis c & d*). At last, we expect that the effect of the visual food-product related extrinsic cue on liking and sensory evaluation of the food will be mediated by simulation (*hypothesis e*). For explorative reasons, we will also look at the effect of manipulation simulation, by using the incongruent and congruent visual food-product related extrinsic cues on expected liking, expected sensory evaluation, desire to eat and purchase and sharing intention.**

The perception of a food item and the amount of its consumption can vary depending on the situational and contextual elements around the food in a visual cue. For example, people pay less attention to the food itself, when the table setting and decoration placed on a dining table gets more salient and complex (Zhang & Seo, 2014). This is why all of the above hypotheses are also tested for the congruent and incongruent condition, compared to a control condition containing a visual cue of the food product without any context. It is interesting to know if the control condition, with its absence of any situational elements, will have the same results or will be totally separate from both the congruent and incongruent condition. Besides this, the inclusion of the control condition may give us insight in how the congruent and incongruent visual cue's effect the simulation, liking and sensory evaluation of the food product.

Methods

Participants and design

A total of 86 participants (65 females, 21 males), ranging from the age of 18 to 60 years (*M*=24,69, *SD*=9.16) has been recruited via different participant recruitment systems. Participants were all right handed, since handedness influences mental simulation of the stimulus material (Elder & Krishna, 2012) and all participants were non-smokers, since smoking has been found to affect salivary flow (Rad, Kakoie, Brojeni, & Pourdamghan, 2011). Furthermore, all participants were instructed to eat a filling meal and fast three hours before the start of the experiment to minimize the variability in how hungry the participants were. In this way, the degree of hunger did not influence the simulation of the eating situation and fasting might make it more likely to simulate the congruent eating situation. The study was conducted between 11 a.m. and 5.30 p.m., to present the soup either as a lunch meal or an afternoon snack.

Material

The aim of this study was to look at the effect of a simulation manipulation, via the different visual product extrinsic cues on the sensory evaluation and liking of a food. There are three conditions in this experiment, used in a between participants design and for all three conditions the simulation was manipulated by a different visual product extrinsic cue, namely:

Condition I. Congruent simulation manipulation. For this simulation manipulation, a visual cue (*figure 2*) was used displaying a food product (tomato soup) in a food-product-congruent eating context (a kitchen). This image was designed in a previous study of this series to elicit simulations of previous consumption experienced and contained features inspired by the work on feature listing by Lindner (unpublished), that should induce simulations of prior experiences with the food product. The features include additional food items (the bread), warmth (coaster and potholder), company (the second bowl) and motor facilitation (the spoon).

Condition II. Incongruent simulation manipulation. For this simulation manipulation, a visual cue (*figure 2*) was used displaying a food product (tomato soup) in a food-product-incongruent eating context (a cinema). This image was also designed by the previous study in this series, in the same way as the image in condition 1. This image (sitting at a table in the cinema) does not include any of the features which induce simulations of prior experience with the food product. The images used in the congruent and incongruent condition were pretested and did not differ significantly in the positivity of the image, the valence and familiarity of the situation depicted in the image and simulation potential without the food product in the image (all $p>.47$).

Condition III. Control manipulation. For this simulation manipulation a visual cue (*figure 2)* was used displaying no situational elements or features, but only the food product itself. This condition is used as a control condition for the other conditions.

Figure 2. **Left: Condition 1 – Congruent product extrinsic cue, Middle: Condition 2 – Incongruent product extrinsic cue, Right: Control condition 3 – Extrinsic cue without any situational elements.**

Procedure

This experiment consisted of the further described six measurements and was mainly carried out in front of a computer (screen size: 1920 x 1080 px), where the participants were shown a questionnaire programmed in Qualtrics.

1. Salivation measurement. Two times salivation measurements were acquired as a physical indicator (indirect) of simulation of the consumption experience, as based on a method described by Keesman et al. (2016). The first measurement to determine a baseline was at the beginning of the experiment and the second measurement was after the simulation manipulation, described in the next paragraph. Prior to measuring, the participants were asked to rinse their mouth with a cup of water. For the baseline salivation, the participants were asked to view an image of a non-food object (a piece of wood) for one minute (Naumann et al., 2013) without swallowing or moving their tongue, after which they were asked to spit into a cup. After taking the saliva sample and measuring it, a three-minute break followed to normalize the saliva production in the mouth, during which participants read a part from the novel 'The Lord of the Rings: The fellowship of the ring' (Tolkien, 2012). Upon the completion of the simulation manipulation part, participants were asked to spit in a cup again.

2. Simulation manipulation. In order to measure the effect of the simulation manipulation, participants were presented with one of the three visual product extrinsic cues (incongruent, congruent or control), asked to immerse themselves in the image they were presented with and try to experience the situation they saw. These instructions did not involve any sensory aspects, to make sure that the simulation of eating the food product was at least partially automatically induced by the image. The image was presented for one minute since this duration has been shown to be sufficient to elicit mental simulations (Keesman et al., 2016).

3. Eating desire & expected liking measurement. For explorative reasons 'desire', 'expected liking' and 'expected sensory evaluation' was measured. To measure 'expected desire', the participants were asked how much they would like to eat the soup shown on the picture and how likely it was that they would buy the soup on the picture (Lawless and Heymann, 2010, Yuksel, 2007 & Arvola et al., 1999) on a 7-point scale. To measure 'expected liking' participants were asked how tasty they expected the soup shown on the picture to be. For 'expected sensory evaluation' people had to rate how salt, savory and spicy they expected the soup to be on a 7-point scale ranging from 'very much' to 'not at all'.

4. Food tasting, liking measurement and sensory evaluation. Tomato soup (250 ml) was served at the temperature of 65º C (Rosett et al., 1997) presented in a bowl and served with a steel spoon similar to the ones used in the extrinsic visual cues. Participants were required to consume at least one spoonful of the soup, but were allowed to eat the entire serving. In the end, it was measured how much soup the participants consumed. During the tasting session, liking scores were acquired by asking the participants to rate the taste of the soup on a 9-point hedonic scale ranging from 'very tasty' to 'very untasty' (Lawless & Heymann, 2010 & Yuksel, 2007). Also, a sensory evaluation of the soup taste was done based on a commonly used sensory perception scale for the particular soup used in this experiment (confidential Unilever R&D report). Participants evaluated the soup on how fat, salty, sour, racy, sweet, bitter, savory and spicy they thought the soup tasted. Again on a 7-point hedonic scale ranging from 'very much' to 'not at all'.

5. Simulation measurement. Participants were asked to answer a number of questions regarding their experience during the minute of simulation. The items in this questionnaire addressed multiple features of simulation, including six items regarding simulation aspects of the soup (based on Keesman et al., 2016), four items regarding contextual features and one item regarding the ease of the simulation (based on Elder & Krishna, 2012)(*Table 1*).

6. Explorative questions and demographic information. For exploratory reasons the participants were asked questions about their familiarity with (ready-made) tomato soup, how likely they would buy and recommend the soup to friends and how healthy they thought the soup was. Finally, some demographic questions were asked.

***Table 1.* Scale division (including Cronbach's alfa reliability scores) for self-reported mental simulation used in the experiment.**

Mental Simulation	
Simulation aspect of soup (*a*=.66)	I imagined eating the soup
	It was like I could taste the soup
	It was like I could feel the texture of the soup in my mouth
(Keesman et al., 2016)	I was imagining how eating the soup would make me feel
	It was like I could feel the warmth of the soup
	I imagined using a spoon to eat the soup
Simulation regarding contextual features of the soup (*a*=.68)	I imagined being in the setting
	I could imagine the details in the setting very precise
	I imagined a very cozy setting
	I felt like it was time to eat
Ease of simulation *(Elder & Krishna, 2012)*	It was easy for me to imagine myself in the setting on the picture

Data analysis

Hypothesis *a*: Effects of the visual extrinsic cues used in the three conditions (congruent, incongruent and control) on self-reported mental simulation were measured by conducting multiple one-way between subjects ANCOVA's. The multiple ANCOVA's were done with every time two out of the three conditions as the independent variable (IV), to compare each time the congruent with the incongruent condition first, as this difference had our particular interest and at second the control condition in comparison to the incongruent or congruent condition. The average scores from one of the three components of simulation (aspects of soup, contextual features or ease of simulation) was repeatedly used as a dependent variable (DV). The scores for how hungry the participants said they felt were taken as a covariate in every ANCOVA, to reduce the error variance the difference in hunger causes on simulation (Chen, Papies & Barsalou, 2016), thus allowing us to assess the effect of the simulation manipulation more accurately.

Hypothesis *b*: To see if there was a difference in the amount of salivation (DV) between the three different conditions, every combination of two conditions were compared as independent variable (IV) by using three separate one-way between subject ANCOVA's. The baseline of how much salivation participants produced was used as a covariate, as well as the scores on how hungry participants felt, because hungriness can make food seem more attractive, again possibly effecting salivation (Berridge, 1991).

Hypothesis *c*: Effect of the different visual cues (congruent, incongruent and control) (IV) on the liking of the food product (DV) was tested by using three different one-way between-subjects ANCOVA's to compare the three conditions. How hungry participants felt was taken as a covariate, as hunger might influence the hedonic evaluation of a product (Berridge, 1991). For the reason that, familiarity with tomato soup ($t(79)=9.30$, p = <0.01), familiarity with ready-made tomato soup ($t(79)=12.20$, p = <0.01) and general liking of ready-made soup ($t(79)=7.87$, p = <0.01) were also significantly related to 'liking', we also controlled for these variables by using them as a covariate.

Hypothesis *d*: Effect of the different visual cues (congruent, incongruent and control) (IV) on sensory evaluation of the food product (DV) was measured using separate independent t-tests. Twenty-four separate t-tests were done comparing the difference between every combination of two out of the three conditions, on every of the eight sensory aspects individually (salt, sweet etc.).

Hypothesis *e*: The SPSS macro developed by Preacher & Hayes (2004) was used to check if there was an indirect effect (mediated by simulation) between the three different conditions on sensory evaluation and liking. Again how hungry participants felt, was taken as a covariate. The first section of the output of this SPSS macro showed the direct regression coefficients, similar to the coefficients obtained from an usual regression, where the second section of the output showed the bootstrap results. Bootstrapping is an increasingly popular method based on resampling with replacement, which was done 5000 times in our analysis. For each of these samples, the indirect effect was computed and a sampling distribution was generated. With this distribution, a 95% confidence interval was determined and it was checked if zero was in between this interval. If not, we could conclude that the indirect effect was significant and calculate the proportion of the total effect that was mediated by simulation.

Exploration. Different one-way between-subjects ANCOVA were conducted to explore the differences in expected liking, desire, expected sensory evaluation, willingness to buy or share the food product with friends (DV's) between the congruent and incongruent condition (IV), whilst controlling for how hungry participants were for expected liking and desire (CV). All the other demographic variables and dietary information were analysed in an exploratory manner.

Results

Mental simulation

Multiple one-way between-subjects ANCOVA's were conducted to see if there was a difference in the amount of simulation between the three conditions (congruent, incongruent and control), whilst controlling for how hungry participants were. 'Simulation' was divided up into three components; the simulation of aspects of the soup, simulation of contextual features regarding the soup and ease of simulation.

At first, the congruent condition led to more simulation of aspect related directly to the soup compared to the incongruent condition, $F(1,52)$ = 12.82, p = <01. Secondly, both the congruent ($F(1,50)$ = 7.62, p = <.01) and incongruent condition ($F(1,50)$ = 8.28, p = .02) led to more simulation of the contextual features than the control condition. And third, the ease of the simulation was significantly higher for the control condition compared to the incongruent condition, $F(1,51)$ = 5.47, p = <.01) (*Table 2 and Figure 3*).

Table 2. **The difference in self-reported mental simulation on a 7-point hedonic scale between the participants who were shown a picture congruent to the situated eating context of the soup (*N*=26), a picture incongruent to the situated eating context of the soup (*N*=27) or a picture of the soup without any situational elements (*N*=26). Controlling for hungriness of the participants.**

	Congruent vs. Incongruent		Congruent vs. Control		Incongruent vs. Control	
	F (1,52)	*p*	*F* (1,50)	*p*	*F* (1,51)	*p*
Simulation aspects of soup	12.82	*.001**	1.87	.178	3.33	.074
Simulation contextual features	.25	*.619*	7.62	.008*	5.47	.023*
Ease of the simulation	2.54	*.117*	8.28	.006*	1.46	.233

**** Significant difference between the conditions p<0.05, two-tailed.***

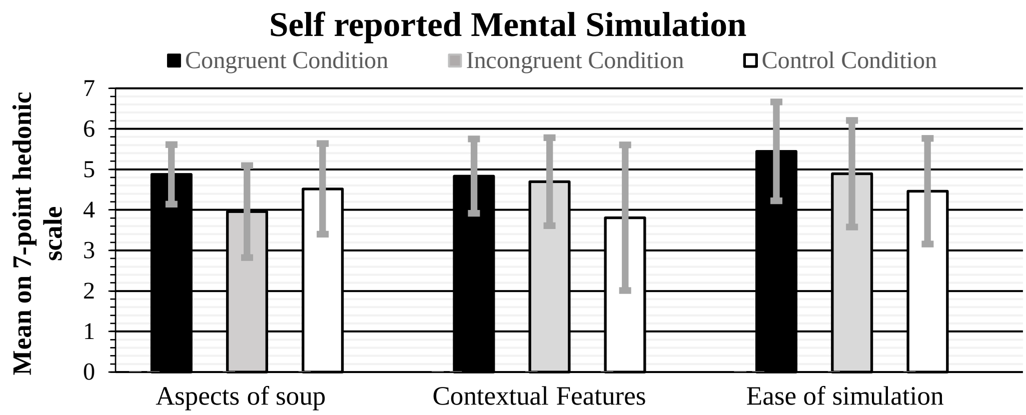

Figure 3. **Difference in the mean of three aspects of self-resported mental simulation per condition. Self-reported mental simulation was measured with a 7-point hedonic scale ranging from 'very much' to 'not at all', between the congruent, incongruent and control condition. The self reported simulation scale was divided up into three components: simulation of different aspects directly linked to the soup, simulation on contextual features regarding the soup and the ease of the simulation (x-axis). The error bars show the standard deviation for each variable.**

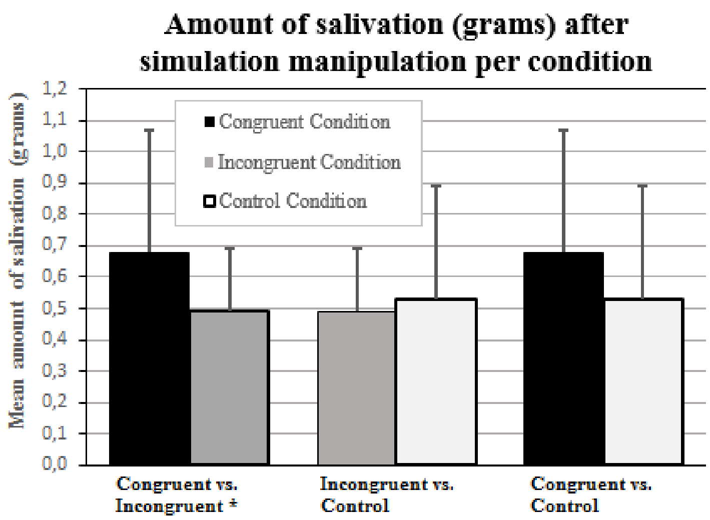

Figure 4. **Difference in mean amount of salivation (grams) between the three conditions after manipulating the simulation. The error bars show the standard deviation for each variable.**
*** The difference between the congruent and incongruent condition is significant, *F*(1,49)10,51, *p*=<.01.**

Multiple one-way between-subject ANCOVA's were conducted to examine if there was a difference in the amount of salivation (grams) between the three conditions (congruent, incongruent and control) after the simulation manipulation, while controlling for the measured salivation baseline for each participant and how hungry the participants were. The congruent condition (*M*=.68 gram, *SD*=.39) led to significantly more salivation compared to the incongruent condition (*M*=.49 gram, *SD*=.20), *F*(1,49) = 10.51, *p*=<.01. No significant difference in salivation was found between the control condition (*M*=.53 gram, *SD*=.36) and the other two conditions *(Figure 4)*.

Liking

Surprisingly, ANCOVA results indicate there is no significant effect in the difference of liking the soup on a 9-point hedonic scale between the congruent condition (*M*=5.33, *SD*=1.33) and incongruent condition (*M*=5.48, *SD*=1,42). Nor was this effect found between the control condition (*M*=5.58, *SD*=1.03) and the other two conditions (all $p>0.46$). This was still the case if we took 'how hungry participants where', 'general liking of ready-made tomato soup' or/and 'familiarity with tomato soup or ready made tomato soup' as a covariate (*Figure 5 in Appendix 1*).

Sensory Evaluation

Results did not indicate any difference between the congruent, incongruent and control condition on any sensory evaluation aspect of the soup (salt, savory, spicy, sour, racy, sweet, bitter, fat) (*Table 3)(Figure 6 in Appendix 1*) (all $p>0.15$).

***Table 3.* The difference in mean (M) and standard deviation (SD) for the different sensory aspects between the three different conditions. Congr. = Congruent condition (N=27), showing people a visual extrinsic cue congruent to the eating situation of the food product. Incongr. = Incongruent condition (N=27), showing people a visual extrinsic cue incongruent to the eating situation of the food product. Control = Control condition (N=26), showing people a visual extrinsic cue with only the food product, without any situational elements. No difference in sensory evaluation between the conditions was found (all *p*>0.15)**

	Salt	Savory	Spicy	Sour	Racy	Sweet	Bitter	Fat
	M ±*SD*	***M*** ±*SD*	***M*** ±*SD*	***M*** ±*SD*	***M*** ±*SD*	***M*** ±*SD*	***M*** ±*SD*	***M*** ±*SD*
Congr.	**4.00** ±1.52	**4.52** ±1.31	**5.30** ±1.17	**2.70** ±1.92	**2.22** ±1.37	**4.11** ±1.64	**1.81** ±1.27	**3.11** ±1.48
Incongr.	**4.00** ±1.36	**4.74** ±1.48	**5.26** ±1.31	**3.19** ±1.71	**2.19** ±1.33	**4.59** ±1.28	**1.52** ±0.93	**2.89** ±1.25
Control	**4.31** ±1.26	**4.92** ±1.13	**5.46** ±0.91	**3.38** ±1.42	**1.88** ±1.24	**4.04** ±1.69	**1.77** ±0.86	**2.69** ±1.16

Mediation mental simulation

A regression analysis was used to investigate the hypothesis that mental simulation mediates the effect of the visual product extrinsic cue on sensory evaluation and liking of a food. Again, mental simulation was split up into: simulation of aspects of the soup, simulation of contextual features regarding the soup and ease of simulation. Results indicated that the difference between the congruent and control condition was a significant predictor of ease of simulation (a-effect), b = .49, SE = .17, $p < 0.05$, and ease of simulation was a significant predictor of liking of a food product (b-effect), b = .32, SE = .12, $p < 0.05$. 'Condition' was no longer a significant predictor of liking of a food product after controlling for the mediator, ease of simulation, b = . 28, SE = .17, $p = .10$. The indirect effect was tested with bootstrapping and these results show that the indirect coefficient was significant, b = .16, SE=.08, 95% CI [.37, .05]. The proportion of the total effect that is mediated was, *Pm*=0.05, which means that the mediator could only account for 5% of the total effect (*Figure 5*).

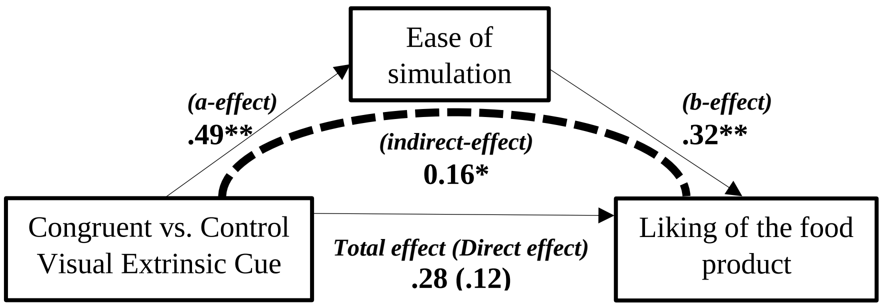

***Figure 5.* Standardized regression coefficients for the relationship between the congruent and control visual extrinsic cue and liking of the food product as mediated by the ease of the simulation.**
*** Significant indirect effect between condition on liking of the food product, mediated by the 'ease of simulation'**
**** *p*<0.05**

No indirect effects of any component of 'simulation' occurred, for the difference between the congruent and incongruent condition in the liking of the food product, nor between the incongruent and control condition for the liking of the food product. No indirect effects of any component of 'simulation' were found either for the difference between sensory evaluation of the soup compared between all the conditions.

Expected liking, expected desire, expected sensory evaluation

Different one-way between-subjects ANCOVA's were conducted to explore the differences in expected liking, desire, expected sensory evaluation, willingness to buy or share the food product with friends between the congruent and incongruent condition, whilst controlling for how hungry participants were. Participants in the congruent condition (N=27) expected to like the soup significantly more than the participants in the incongruent condition (N =27), $F(1,51)$ = 9.20, p = <.01. Also, the desire to eat the soup was just significantly higher in the congruent condition, compared to the incongruent condition, $F(1,51)$ = 4.00, p = 0.05. No significant differences were found between the congruent and incongruent condition in expected saltiness, expected savoriness, expected spiciness and willingness to buy or share the food product with friends.

Discussion

To conclude, we have found that showing a visual extrinsic cue, congruent to the situated food eating context (in this research tomato soup in a kitchen), leads to more simulation on aspects directly related to the food product itself compared to showing a visual cue which is incongruent to the situated food eating context (tomato soup in a cinema). So, simulation of the consumption experience of the soup is manipulated by showing a simple visual extrinsic cue. Manipulation of this simulation by the visual cue, congruent to the food-product eating situation, also leads to more desire to eat the food and more positive expectation of liking the food, compared to the visual cue, incongruent to the food-product eating situation.

These findings fit within the theory of grounded cognition, which suggests that when people conceptualize something, they don't conceptualize it in an isolated way, but conceptualize it with corresponding settings, cognitive perspectives and in a context-appropriate way (Papier & Barsalou, 2015). That's why a simple visual cue congruent to the food product eating-setting (tomato soup in a kitchen) led to multimodal pattern completion, which facilitated the mental simulation of the other soup-related aspects; like eating and tasting the soup, feeling the texture of the soup, the feeling of eating the soup, the warmth of the soup and eating it with a spoon. But as predicted the simulation also triggered appetitive responses to rewarding stimuli in similar brain regions as the consumption itself (Keesman et al., 2016), as the congruent visual cue led to more salivation compared to the incongruent visual cue. Salivation to food is often taken as a proxy for a desire to eat (Gal, 2012, Keesman et al., 2016), that's why the difference in salivation could also be explained by the fact that showing our congruent visual cue led to more desire to eat the food and participants expecting to like the soup more, compared to the incongruent visual cue. So, manipulation of the simulation can influence intentions and expectations towards the food product.

Surprisingly, the results did not indicate any direct or indirect (through the mediation of simulation) effects between the congruent and incongruent visual cues and the liking of the food product or the sensory evaluation. Remarkable, because the participants in the congruent condition expected to like the soup more and had more desire to eat the soup, compared to the participants in the incongruent condition and we know expectation can strongly influence the evaluation of the soup. As explained by the '*assimilation-contrast model'*, based on the cognitive dissonance theory (Festinger, 1957, as described in Okamoto & Dan, 2013), we want to minimize the 'mental discomfort' between our expectation and experience. If there is a small incongruence between our experience and our expectation, this will cause the expectation of the food flavour to be ‘accepted’. While a large incongruence will cause that the gap between expectation and experience to be increased (contrast effect) (Okomato & Dan, 2013), which may have happened in this research as the expected liking and the liking of the food product after the tasting session, were not significantly related.

Nonetheless, we have to take into account that humans are unreliable sensory measuring instruments. Sensory evaluation by untrained participants is very variable over time, very variable among the different participants themselves and highly prone to biases. This was supported by Lawless & Heymann (2010) who showed that untrained sensory testers can not clearly understand the terminology of the evaluation questions, do not recognize the flavour or texture parameters in the products or do not feel comfortable with the mechanics. To minimize errors, we choose to carefully set up the experiment and control for multiple variables influencing flavour perception, but as noted by Lawless & Heymann (2010) error variance can also be minimized by selecting and training panelists. Errors will occur when student participants are selected, because these participants come with varying degrees of acumen, training, experiences, genetic equipment, sensory capabilities and different preferences. So it may have been that the student participants in our research were unable to clearly report their experience and evaluate the flavour of the soup, thus muddling the results of the effect of the simulation manipulation on these aspects. However, in this experiment, we wanted to represent an everyday untrained population and as said an untrained population is more prone to biases, which could have caused them to be easier manipulated by the simulation. Hence, it is recommended for future research to explore the difference between an untrained and trained population for the effect of simulation manipulation on sensory evaluation.

To explore the effect of the food-related contextual features in the visual cue, we need to look at the conclusions for the control visual used in this experiment, compared to the congruent and incongruent visuals. It can be concluded that contextual features make it easier to simulate the soup consumption experience, as the congruent condition led to easier simulation than the control visual without any contextual features. The difference in ease of simulation between this congruent and control variable even slightly mediated the effect of the condition on the liking of the food product. So, if simulation becomes easier by adding contextual features to the visual cue, the evaluation of the product in terms of liking seems to be partly influenced by this ease of simulation. We decided to explore the effect of a control visual cue with no situational elements, as we are aware of the fact that these separate situational elements can effect the taste perception in many different ways. Which brings us to the overall disadvantage of using a high level visual with lots of semantics and meaning involved. This holistic approach fitted our research question, but the disadvantage is that we couldn’t control for things like the amount of different situational elements or visual elements like luminance or contrast.

As we chose to only show one kind of food product to every participant, we can not generalize the results to any other food. One reason for choosing to show participants one instead of multiple food products, is that research suggests that repeatedly making participants imagining food consumption may lead to habituation effects like decreased consumption of the food afterwards (Morewedge et al., 2010). Also, saliva production might decrease when obtaining multiple samples (Keesman et al., 2016).

To conclude, the present study examined if a visual cue congruent or incongruent to the food product eating context could impact the simulation of a food product differently and if or in what way this simulation manipulation had an effect on the liking and sensory evaluation of the food product. We demonstrated that visual cues with the food product in a situation congruent to the food-product eating context can lead to more simulation, salivation, desire to eat the food product and expected liking of the food. However, due to participants being untrained, results could have been prone to errors, possibly explaining why no indirect and direct effect were found for simulation manipulation on the sensory evaluation and liking of the food product. Nonetheless, it has been found that using congruent food product contextual features in the visual cue make it more easy to simulate the soup consumption experience.

So using simple visual cues, with congruent contextual features related to the food product can unconsciously move consumers towards the choice of healthy food, as they can easily simulate themselves eating the food and their desire to eat the food will increase. This desire may also lead to an easier acceptance of the reformulated salt-reduced food for the consumer, but more research is needed on how these subtle unconscious cues can also influence the taste perception itself. To promote healthy food choices, much more research remains to be done on subtle cues influencing mental simulation of the consumption experience and the influence of these simulations on perceptions and other bahaviour of the consumer.

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Appendix 1

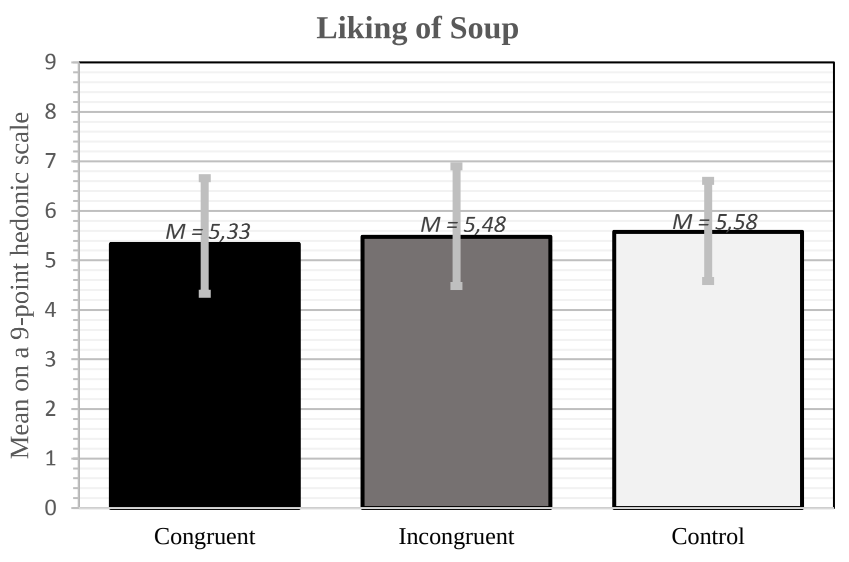

Figure 5. **Difference in the mean of liking the soup after tasting it between the three different conditions (congruent, incongruent and control), rating the soup on a 9-point hedonic scale ranging from 'very tasty' to 'very untasty'. No significant differences were found. The error bars show the standard deviation for each variable.**

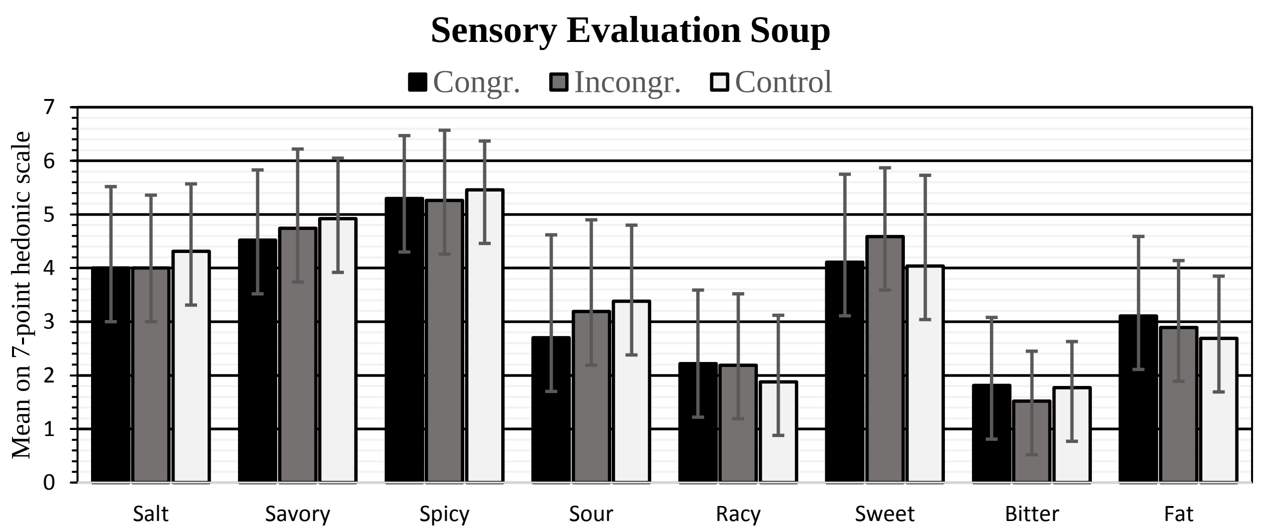

Figure 5. **Difference in the mean of eight different sensory evaluation attributes of the soup participants tasted, between the three different conditions. Congr. = Congruent condition, exposed to a visual of a situation congruent to a soup-eating situation (soup in a kitchen). Incongr. = Incongruent condition exposed to a visual of a situation incongruent to a soup-eating situation (soup in a cinema). Control = Control condition, exposed to a visual of a soup item with no situational elements. Participants evaluated the soup on how fat, salty, sour, racy, sweet, bitter, savory and spicy they thought the soup tasted. Again on a 7-point hedonic scale ranging from 'very much' to 'not at all'. The error bars show the standard deviation for each variable.**