The taste of touch: Enhancing saltiness impressions through surface texture design

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ABSTRACT

Previous research demonstrates that surface textures of product packaging and sample cups can steer basic taste perceptions and product evaluations. This study investigates whether saltiness perceptions and related product evaluations following consumption of potato chips can be enhanced through texture design. Additionally, this study includes both regular chips and no-salt chips in order to test whether texture influences vary depending on saltiness levels. An experimental study was conducted at a supermarket in which shoppers participated in a taste test. Potato chips were sampled from either a regular or texture-enhanced sample cup. Results testify to the feasibility of enhancing saltiness impressions and related measures through texture design, but show that these effects vary with chips type and may backfire for no-salt chips. Implications for follow-up research, initiatives aimed at promoting healthy food choices, and design practice are discussed.

1. Introduction

Reducing sodium (commonly referred to as salt) intake is generally considered as one of the most pressing health challenges when it comes to food and beverage consumption (Kloss, Meyer, Graeve, & Vetter, 2015). Initiatives to tackle this challenge include, amongst others, food reformulation (i.e., the action of changing the composition of processed foods) and a traffic light system (used in the UK) to indicate sugar, fat, and salt contents (e.g., ‘red’ meaning that a product should be consumed with caution). However, so far, the recommended intake level of < 5 g salt/day has not been achieved across European countries. And although consumer awareness of health risks associated with sodium intake (high blood pressure in particular) is steadily growing, people generally entertain a preference for salted foods, and are apt to experience low-sodium foods as bland or tasteless (Stein, Cowart, & Beauchamp, 2012).

Interestingly, recent studies assessing the impact of design factors on food experience indicate that visual and tactile aspects can influence basic taste sensations (e.g., evaluations of sweetness and bitterness) and hedonic taste evaluations (e.g., Biggs, Juravle, & Spence, 2016; Ngo, Misra, & Spence, 2011; Van Rompay, Finger, Saakes, & Fenko, 2017; Van Rompay, Kramer, & Saakes, 2018; Velasco, Woods, Petit, Cheok, & Spence, 2016). For instance, Ngo et al. (2011) visually presented different shapes in combination with different types of chocolate and showed that sweetness is readily associated with smooth, organic shapes. In line with these findings, Van Rompay et al. (2017) showed that sweetness evaluations (e.g., of a chocolate drink) were enhanced by a circular surface texture. In a follow-up study, a sour lemon sorbet ice cream was evaluated as even sourer when sampled from a cup with a sharp-feeling (rather than a smooth) surface texture (Van Rompay et al., 2018).

Although these studies were not explicitly aimed at enhancing acceptance and consumption of healthy food alternatives, they do suggest that evaluations and purchases of healthy food options (i.e., foods and beverages containing lower amounts of fat, sugar or salt) could be enhanced by manipulating ‘look and feel’ properties of product packaging and (sample) cups. Furthermore, by enhancing hedonic evaluations of healthy food alternatives, tactile design may be an important tool for overcoming health-compromising heuristics which consumers may entertain such as ‘healthy is not tasty’ (Raghunathan, Naylor, & Hoyer, 2006).

With respect to the question if and how saltiness impressions can be traced to visual or tactile design parameters, research is silent. However, several studies have looked into cross-modal correspondences between tastes and musical compositions (e.g., Knoeferle, Woods, Käppler, & Spence, 2015; Mesz, Trevisan, & Sigman, 2011). For instance, in Mesz et al. (2011) musicians were asked to generate musical improvisations corresponding to the basic tastes. Findings showed that ‘salty’ improvisations were ‘staccato’, with notes of short duration sharply detached from the others, conveying a rough character (as

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opposed to a ‘smooth melody’). Furthermore, they comprised successive notes with widely differing pitches (i.e., a high level of irregularity; see Spence [2012] for a review on correspondences between sounds and sensory attributes of foods and beverages).

These findings suggest that saltiness experience involves sensations of irregularity and roughness (as opposed to smoothness and evenness). It would be particularly worthwhile to investigate whether tactile sensations differing on these aspects also impact saltiness evaluations in food products. Specifically, we will study whether saltiness perceptions in a salty snack (in this study potato chips) can be enhanced through a surface texture embedded on the cup from which the chips are sampled. To this end, a 2 (surface texture: uneven and rough versus even and smooth) x 3 (potato chips: no-salt versus two regular potato chips variants) between-subjects design was employed to study consumers’ evaluations during a sample test conducted at a supermarket. Before elaborating on the details of this study, first we will elaborate on the key constructs involved.

1.1. Tactile design and taste evaluation

In recent years, a considerable body of research has emerged testing to the potential of materials and textures to trigger qualitatively different taste experiences (Biggs et al., 2016; Piqueras-Fiszman & Spence, 2012; Schifferstein, 2009; Spence & Wan, 2015; Van Rompay et al., 2018). For instance, Piqueras-Fiszman and Spence (2012) showed that biscuits in a rough package were rated as being crisper than identical biscuits sampled from a smooth package. Similarly, Van Rompay et al. (2018) showed that the taste of vanilla ice cream was evaluated as sweeter when sampled from a smooth-feeling (rather than a sharp-feeling) sample cup.

These findings show that expectations formed prior to tasting (i.e., expectations based on visual or tactile exposure to package or cup) can influence subsequent taste experiences. Furthermore, the results of these diverse studies reveal so-called crossmodal correspondences, defined as tendencies for certain sensory features or dimensions from one sensory modality (e.g., touch) to be associated with sensory features or dimensions in another modality (e.g., taste; see Spence, 2011 for a review). Although pervasive throughout daily experience, accounting for such correspondences is less straightforward and may (depending on the type of correspondence involved), include associative learning, metaphorical (linguistic) mappings, and/or structural perceptual determinants (see Deroy, Crisinel, & Spence, 2013 for a review).

However, of as of yet, there are few indications as to what specific textures could enhance saltiness perceptions and the cross-modal correspondence(s) involved. However, in line with aforementioned study by Mesz et al. (2011), uneven and rough surface textures might be good candidates for enhancing saltiness Impressions. This idea also aligns with the embodied cognition framework within which the basis of sensory evaluations is traced to physical interactions with objects (Van Rompay & Ludden, 2015). In the case of salt, the idea is that sensory impressions would include associative learning, metaphorical (linguistic) mappings, and/or structural perceptual determinants (Deroy, Crisinel, & Spence, 2013). Hence, based on the above, it is expected that:

H1: An uneven and rough (as opposed to an even and smooth) surface texture enhances saltiness perceptions.

When looking for more structural determinants contributing to saltiness perceptions (e.g., what are common dimensions across various sensory modalities?), intensity has been frequently pointed out as such an ‘amodal’ dimension (Deroy et al., 2013; Osgood, Suci, & Tannenbaum, 1957). In line with this argument, several studies have demonstrated couplings between textures that make a sharp, intense sensation on our skin and evaluations of taste intensity and taste sensations sharing this dimension of intensity such as bitter and sour (e.g., Van Rompay et al., 2017, 2018). With respect to saltiness, taste intensity is particularly relevant as lowering saltiness may readily trigger perceptions of a bland flavour, especially for salty snacks such as potato chips (a prototypical example of a ‘salty’ product; Kloss et al., 2015). Based on previous studies showing that textures which make for a distinct, intense impact on our skin translate into enhanced evaluations of taste intensity (Van Rompay et al., 2017, 2018), we expect that:

H2: An uneven and rough (as opposed to an even and smooth) surface texture enhances taste intensity perceptions.

As for more general measures (in this study taste liking and willingness to try), we likewise expect that a texture enhancing saltiness perceptions also enhances consumers’ product evaluations, resulting in higher taste liking and a greater willingness to try. That is, considering consumers’ preferences for salty foods (and corresponding dislike for a ‘bland’ flavour) (Stein et al., 2012), a texture enhancing saltiness and intensity impressions should positively influence taste and product liking as well. Hence:

H3: An uneven and rough (as opposed to an even and smooth) surface texture enhances taste liking and willingness to try.

But what happens when expectations radically diverge from subsequent food experiences? More specifically, what happens when a shopper is anticipating a salty snack but subsequently tastes a no-salt snack? Particularly relevant to the present context are studies suggesting that the influence of extrinsic cues on sensorial evaluations will vary depending on the gap between expectations (formed prior to tasting) and subsequent sensorial impressions (i.e., the size of anticipation–reality divergence; Cardello & Sawyer, 1992; Davidenko et al., 2015; Yeomans, Chambers, Blumenthal, & Blake, 2008). To illustrate, Yeomans et al. (2008) studied the interplay between food labels and taste evaluations and they showed, for instance, that when consumers are confronted with an ice-cream label generating strong expectations of a sweet flavour, but subsequently taste a very salty (rather than sweet) ice cream, sweetness ratings decrease, clearly demonstrative of a contrast effect. In line with these findings, Davidenko et al. (2015) studied the interplay between labels and flavored drinks by systematically varying taste intensity. Findings were demonstrative of both assimilation and contrast effects (depending on the drink-label combination).

These combined findings suggest that when sensations triggered by food tasting radically diverge from initial expectations, the source of the initial expectation (i.e., the package or the sample cup) is discounted (cf. Wang, Reinoso Carvalho, Persoone & Spence, 2017). By consequence, taste evaluations may shift in the opposite direction, resulting in contrast (rather than assimilation) effects (Hovland, Harvey, & Sherif, 1957; Schifferstein, 2001). Obviously, such findings are highly relevant to the health context as it is here in particular that taste experiences of food products with low levels of, for instance, salt might (radically) diverge from taste experiences of regular (full-salt) variants, a ‘gap’ further enhanced by a package or cup suggestive of high levels of saltiness. The question thus becomes whether (and when) enhancing saltiness expectations through sample cup texture backfires. In line with the above, such a contrast effect should occur when the gap between what is expected (e.g., a salty snack) and what is subsequently tasted (e.g., a no-salt snack) becomes too large. To our knowledge, research studying this interplay between surface textures (and the expectations they generate) and actual saltiness experiences is non-existent.

Hence, in this research we will manipulate both surface texture and actual food saltiness (distinguishing between a no-salt, and two salted potato chips variants) in order to study assimilation and contrast effects. Specifically, we will test whether the influence of surface texture design is moderated by product saltiness. Hence:

H4: Surface texture design contributes to enhanced taste and product evaluations for regular, as opposed to no-salt, potato chips only.

To test these hypotheses, a full-factorial 2 (surface texture: uneven/rough versus even/smooth) x 3 (product type: no-salt versus two full-salt variants) between-subjects design was employed.
2. Method

2.1. Pretest

Two sample cups were developed (see Fig. 1). To this end, two identical standard cups were used (top diameter: 15.5 cm; bottom diameter: 7 cm; height: 7.5 cm), of which one was painted over with plaster paint (brand: ‘KARWEI’). Fifteen participants (8 male, 7 female; mean age: 30.9 years) assessed texture ‘feel’ (measured with the bipolar items ‘rough-smooth’, ‘uneven-even’, and ‘irregular-regular’; alpha = 0.99) and realism (measured with the items ‘this cup is appropriate for salty snacks’, and ‘this is a realistic sample cup’; alpha = 0.84) of both sample cups. Findings showed that there were no differences between the sample cups in terms of realism ($F(1, 28) = 0.47, p = .50, \eta^2 = 0.02$), but that the cups differed significantly in terms of tactile feel ($F(1, 28) = 5986.91, p < .001, \eta^2 = 0.99$), confirming appropriateness and effectiveness of our surface texture manipulation.

Left panel: uneven and rough texture; right panel: even and smooth texture

Similarly, a pretest was conducted for selection of the potato chips variants. To this end, 15 participants (8 male, 7 female; mean age: 35.3 years) rated five different potato chips types (all existing brands) on the item ‘these potato chips taste salty’. Based on these results, the following three potato chip brands were selected for the main study: Lays natural chips ($M = 6.0, SD = 0.53$; actual salt content: 3.47 gr), Pringles natural chips ($M = 4.0, SD = 0.92$; actual salt content: 1.2 gr), and Tyrrells natural chips ($M = 2.0, SD = 0.53$; no salt). The difference here between actual salt content and perceived saltiness should be noted. Thus, although the Lays and Pringles chips are close in terms of actual salt content, perceived saltiness differed significantly between all three variants (all comparisons $p < .001$). For that reason, we decided to use three potato chips variants (from now on referred to as: no-salt, medium-salt, and full-salt).

2.2. Participants and procedure

Permission to conduct the study was obtained from our university’s ethics committee (see: https://www.utwente.nl/en/bms/research/ethics/). 180 shoppers of a supermarket in a middle-sized Dutch city (91 males, 89 females; mean age: 40.2 years; age range: 18–82 years) participated in the experiment. A chi-square test showed that gender distribution across the conditions ($X^2(5, N = 180) = 3.05, p = .69$). Likewise, there were no differences in terms of age across the six conditions ($F(5, 174) = 0.98, p = .43, \eta^2 = 0.03$; see also Table 1). Shoppers were approached upon entering the supermarket and upon agreement, it was first ensured that there were no dietary restrictions. Next, participants were informed that they would be participating in a potato chips sample test and that their first impressions would be recorded. Subsequently, one of the two sample cups with one of the product variants (containing a few chips) was handed to the participants in order to ensure physical contact with the surface texture and that they actually tasted the chips while holding the sample cup in their hands. Hence, participants had both visual and tactile contact with the sample cup and its contents. In order to ensure freshness of the potato chips, the larger actual package (not visible for the participants) was sealed after each series of taste trials (and never used on two consecutive days). After tasting, participants handed over the sample cup and filled out the questionnaire comprising the dependent measures.

2.3. Measures

As participants were actual shoppers entering the supermarket, for practical reasons, a brief questionnaire (comprising the dependent measures) was used. All responses were recorded using 7-point rating scales.

2.3.1. Taste evaluation measures

Participants first rated the taste of the potato chips on perceived saltiness by indicating to what extent they agreed with the statement ‘These potato chips taste salty’ (scale anchors: not at all, very much so).

Taste intensity was measured by asking participants to indicate their agreement with the statements ‘I would describe the taste of these potato chips as strong’ and ‘I would describe the taste of these potato chips as bland’ (reverse coded) (alpha = 0.89).

Taste liking was measured with the statements ‘I like the taste of these potato chips’, ‘The taste of these potato chips pleases me’, and ‘These potato chips taste just right’ (alpha = 0.96).

Finally, we assessed crispiness considering its importance to snacks and potato chips in particular. To this end, participants indicated to what extent they agreed with the statement ‘These potato chips are crunchy’.

2.3.2. Product evaluation measure

We used ‘willingness to try’ as a proxy to shoppers’ purchase intentions. Participants indicated their agreement with the following statements: ‘I would consider buying this product’, ‘I am interested in this product’, and ‘I would like to try out this product’ (alpha = 0.73).

3. Results

3.1. Perceived saltiness

Starting out with perceived saltiness, an ANOVA with ‘cup’ and ‘product type’ as independent variables and perceived saltiness as dependent variable yielded (as expected) a significant main effect of chips type ($F(1, 174) = 943.25, p < .001, \eta^2 = 0.92$), confirming that the three different potato chips significantly differed in terms of saltiness perception (all multiple comparisons, $p < .001$, see also Fig. 2). More importantly, the main effect of cup was also significant ($F(1, 174) = 74.55, p < .001, \eta^2 = 0.30$), showing (in line with H1) that the rough and uneven texture resulted in enhanced perceptions of saltiness ($M = 4.68, SD = 2.35$) in comparison to the smooth and even surface texture ($M = 3.89, SD = 1.85$). Importantly (and in line with H4), the interaction between texture and product type was significant ($F(1, 174)$...
Follow-up analyses show that this effect only applies to the medium ($F(1, 174) = 93.88, p < .001, \eta^2 = 0.35$) and full salt ($F(1, 174) = 34.78, p < .001, \eta^2 = 0.17$) product variants. In the no-salt condition, the effect of surface texture is non-significant ($F(1, 174) = 0.40, p = .53, \eta^2 = 0.002$).

3.2. Taste intensity

Likewise, for taste intensity (strongly correlated with perceived saltiness: $r = 0.90, p < .01$), the main effect of chips type is significant, confirming that lowered salt contents indeed trigger perceptions of a less intense taste ($F(1, 174) = 698.82, p < .001, \eta^2 = 0.89$; see also Fig. 3). Multiple comparisons confirm that all three chips types differ significantly from each other (all $p$'s < 0.001). The main effect of cup is again significant ($F(1, 174) = 25.10, p < .001, \eta^2 = 0.13$), showing that (in line with H2) the rough and uneven texture triggered a more intense taste experience ($M = 5.10, SD = 2.07$) compared to the smooth and even texture ($M = 4.63, SD = 1.90$). Finally, the interaction between cup and product type was again significant ($F(1, 174) = 10.76, p < .001, \eta^2 = 0.11$; see Fig. 3). Follow-up analyses show that this effect (in line with H4) only applies to the medium ($F(1, 174) = 29.28, p < .001, \eta^2 = 0.14$) and full-salt ($F(1, 174) = 16.68, p < .001, \eta^2 = 0.09$) product variants. Similar to the results for perceived saltiness, in the no-salt condition, the effect of surface texture was non-significant ($F(1, 174) = 0.67, p = .42, \eta^2 = 0.004$).

3.3. Taste liking

For taste liking, the main effect of chips type was significant ($F(1, 174) = 365,48, p < .001, \eta^2 = 0.81$), showing that the taste of the medium ($M = 6.34, SD = 0.45$) and high-salt ($M = 6.48, SD = 0.36$) variants was liked better than the taste of the no-salt chips ($M = 3.06, SD = 1.23$; both $p$'s < 0.001). This time, the difference between the medium and full-salt variants was not significant ($p = .33$). The main

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**Fig. 2.** Interaction between cup and product type on perceived saltiness.

**Fig. 3.** Interaction between cup and product type on taste intensity.
effect of cup ($F(1, 174) = 0.12, p = .73, \eta^2 = 0.001$) and the interaction between product type and cup were not significant either ($F(1, 174) = 0.98, p = .38, \eta^2 = 0.01$). Hence, for taste liking, H3 and H4 could not be confirmed.

3.4. Willingness to try

As for willingness to try, the main effect of chips type was again significant ($F(1, 174) = 192.59, p < .001, \eta^2 = 0.69$), showing that scores were significantly higher for the full-salt and the medium-salt variants compared to the no-salt variant ($p$'s < 0.001). Likewise, the difference between the full-salt and medium-salt variants was significant ($p = .002$; see also Fig. 4). The main effect of cup was (in contrast to H3) not significant ($F(1, 174) = 0.30, p = .59, \eta^2 = 0.002$). Finally, the interaction between cup and chips type was again significant ($F(1, 174) = 3.90, p = .02, \eta^2 = 0.04$; see Fig. 4).

Follow-up analyses however show a somewhat different pattern compared to the interaction effects for saltiness and taste intensity. That is, within the no-salt variant, willingness to try is higher when the chips are sampled from the smooth and even cup ($F(1, 174) = 6.45, p = .01, \eta^2 = 0.04$), indicative of a contrast effect. For the medium ($F(1, 174) = 0.13, p = .72, \eta^2 = 0.001$) and the full-salt variant ($F(1,174) = 1.52, p = .22, \eta^2 = 0.01$), the differences between the cups are not significant.

3.5. Crispiness

As for crispiness, the main effects of product type ($F(1, 174) = 1.17, p = .31, \eta^2 = 0.01$) and cup ($F(1, 174) = 0.67, p = .42, \eta^2 = 0.004$) were non-significant, neither was the interaction between cup and product type ($F(1, 174) = 0.17, p = .85, \eta^2 = 0.002$).

4. Discussion

The findings reported testify to the feasibility of managing saltiness impressions by means of surface texture design. Specifically, they suggest that uneven and rough surface textures can enhance saltiness and related taste intensity impressions. These findings are important when considering health issues associated with salt consumption and current initiatives to make shoppers more aware of salt contents in foods and beverages (e.g., UK’s traffic light system) and food modification practices. In other words, managing saltiness experience through extrinsic (though product-related) design factors might be considered a complementary strategy in this regard. When also considering ‘new’ means for generating ‘salt-enhancing’ interactions (i.e., coating technologies, 3D-printing, and usage of smart materials; see Velasco, Obrist, Petit, & Spence [2018] for a review), such a strategy certainly warrants further consideration in the food and health domains.

Of equal importance, however, is the finding that applications of surface textures require consideration of the gap between expectations triggered through surface texture design and actual food contents. That is, the positive effects of texture on saltiness and taste intensity impressions were only apparent for the medium and high salt variants, but not for the no-salt variant. Furthermore, when considering the findings on willingness to try, the effect of texture design backfired for the no-salt variant; participants were less ‘willing to try’ the potato chips when sampled from the ‘salty’ cup with the uneven and rough surface texture. These findings indicate that when shoppers cannot reconcile impressions triggered by surface texture with subsequent taste impressions, a contrast, rather than assimilation, effect occurs (cf. Davidenko et al., 2015). In a similar line of reasoning, and close to our findings, Kuenzel, Zandstra, El Deredy, Blanchette and Thomas (2011) showed that the nature of the drink itself modulates assimilation effects (i.e., with no effects of cues found for salty, rather than sweet, yoghurt in their study).

Clearly, follow-up research is warranted in which the gap between texture design and actual saltiness is systematically manipulated (i.e., by systematically varying salt contents as opposed to using existing potato chips variants) for different snack and food types. After all, saltiness expectations are in the case of potato chips particularly high. It is an open question to what extent this enhances or reduces the likelihood of assimilation and contrast effects. Additionally, it would be particularly important to include products with gradual variations in salt contents (as opposed to the ‘all or nothing’ distinction between no-salt and regular chips in this study) in order to pinpoint where assimilation turns into contrast and vice versa. And what about the distinction between more traditional, explicit elements (such as verbal information presented through product labels) and arguably more subtle design elements such as the surface textures studied here? Are, for instance, contrast effects less likely to occur when it comes to more subtle design elements as these provide more opportunities for consumer-generated expectations (rather than expectations imposed by explicit...
information; cf. Krishna, 2012). Of further interest, Wilcox, Roggeveen, and Grewal (2011) showed that a discrediting cue (i.e., a cue which calls the relevance of the information presented via, for instance, a label into question) may weaken or minimize assimilation effects. This latter finding is of particular relevance in so for it shows that when consumers discredit the source of initial impressions (either because of external information as in Wilcox et al. (2011), or because the information presented diverges too much from subsequent food experiences as in our study), assimilation effects are nullified, and as our findings on ‘willfulness to try’ suggest, sometimes even reversed.

4.1. Limitations and shortcomings

Clearly, several limitations deserve attention as well. First of all, it is important to note that we used existing potato chips brands which not only differ in saltiness but also in terms of, for instance, smell, structure, and thickness. Hence, we cannot rule out that these factors influenced the results presented (although note that these confounding variables cannot provide an alternative explanation for the interaction effects observed). As a matter of fact, such confounds did influence saltiness impressions. That is, although salt contents of the medium and full-salt variants were pretty close, perceived saltiness scores differed markedly (both in the pretest and in the main study).

Furthermore, the effects of surface texture were not significant for taste liking and willingness to try. Arguably, these null-results here relate to the fact that the scores for the two regular chips variants were six or higher (on a 7-point rating scale), and thus perhaps indicative of a ceiling effect. Finally, we can also not rule out that differences in terms of popularity and familiarity with the chips brands influenced our results.

Another shortcoming relates to the surface textures used in this experiment which differed on two aspects (evenness and roughness). As such, we cannot pinpoint which design aspect(s) are primarily responsible for the heightened saltiness impressions observed in this study. However, the fact that the texture manipulation had no effect at all on crispiness evaluations (whereas its effect on saltiness evaluations was very pronounced) rules out that the results obtained here can be attributed to a more general halo-effect (by means of which all taste evaluations would be enhanced or intensified by a pleasantly surprising surface texture). In other words, our findings testify to the feasibility of enhancing saltiness impression through texture design and provide suggestions as to which features are of particular importance.

Having said so, it could be the case that textures which make for an intense sensation on our skin (such as the texture used in current research, but see also Van Rompay et al. (2017, 2018) for examples of other ‘intense’ textures) influence a wider range of taste evaluations which share an element of intensity (e.g., bitter, sour, and salt). For instance, it would be more than interesting to include different chips flavors (e.g., natural chips and sour chips such as Lay’s sour cream-flavored chips) to explore the feasibility of developing taste specific textures, or whether more general constructs such as intensity should be point of departure when designing surface textures (a notion in line with proposals suggesting that cross-modal correspondences rely on indirect or transitive mappings across modalities; Deroy et al., 2013).

Of further interest with respect to texture design is research demonstrating a relationship between smoothness and pleasantness, and roughness and unpleasantness (Etzi, Spence, & Gallace, 2014). Following an (embodied) line of reasoning, roughness is linked to friction (between hands and texture) experienced in interacting with rough textures (Etzi et al., 2014). This could also account for the positive effect of smoothness on (pleasure-related) ‘williness to try’ for the no-salt chips, whereas for the regular chips variants (where taste is more intense and arguably more dominant vis-à-vis tactile impressions), such an affecting priming effect would be less likely to transpire.

Finally, the texture manipulation not only influenced tactile sensation but influenced the visual appearance of the sample cup too. Clearly, these limitations call for more systematic variations in both texture design and salt contents, and for disentanglement of visual and tactile cues. Of interest in this respect, recent advances in 3-D printing not only allow for systematic texture variations, they also enable more subtle variations which have a far less pronounced impact on visual appearances (e.g., Torres, Campbell, Kumar, and Paulos, 2015).

And then of course, there is the question of how to implement these findings in people’s everyday life? Although by now a considerable body of research (including the present study) attests to the feasibility of managing taste sensations by extrinsic cues related to packaging, sample cups, plateware, etc. (Piqueiras-Fizman & Spence, 2015), how to (literally) integrate textures and related design cues in people’s encounters with foods and beverages across settings (ranging from supermarkets to restaurants to people’s home environments)? And what about effects of extrinsic design features in the long term? Will such benefits persist when habituation kicks in, or will they fade away in the long term?

This latter question takes on increased relevance when considering opportunities which smart materials provide when it comes to dynamic adjustments of design features based on (sensor-generated) feedback about food composition (see also Velasco, Obrist, Petit, & Spence, 2018). Answers to such questions and challenges are crucial in order to make the transition from (academic) insights to applications in everyday life that are so very much needed to address societal challenges related to (over)consumption and lifestyle management.

5. Conclusion

In concluding, we feel confident when saying that our results underscore the potential of an approach through which healthy food consumption is stimulated by means of evidence-based texture manipulations. Awaiting follow-up studies further unravelling the specific (psychological) processes, and providing clarity on specific taste-texture couplings (e.g., can we develop specific, distinct textures for the basic taste sensations, or should we target our efforts at more general constructs?), such an approach might be considered complimentary to existent initiatives including food reformulation and warning systems.

References