Tasting touches:

The influence of tactile stimuli on the salt perception, hedonic taste evaluation and health perception of the consumer

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Abstract

Purpose

This research focuses on reducing excessive salt intake, as this is one of the most pressing health challenges of our time. The aim of this study is to influence the salt perception of the consumer by manipulating the texture of serving packages, since several previous studies have found that tactile stimuli can influence the product and taste evaluation of consumers. Although many relations between different tastes and tactile stimuli already have been demonstrated, it was unclear prior to this study which design aspects influence salt perception. This study therefore investigates which texture design influences the salt perception, hedonic taste evaluation and health perception.

Method

A 3x3 experimental design was carried out, in which 3D printed packaging textures (smooth vs. rough vs. rough/granular) and salt levels in bouillon (minimum salt vs. medium salt vs. maximum salt) were manipulated. Effects on saltiness perception, hedonic taste evaluation and health perception were measured by means of ANOVA's. A total of 270 respondents participated in this study. During the study, respondents received one of the three 3D printed cups containing one of the three types of bouillon. After the respondents drank some of the bouillon, they filled in a questionnaire.

Findings

The different salt levels have an influence on salt perception, hedonic taste evaluation and health perception. It appears that a higher salt level results in a higher salt perception and hedonic taste evaluation and a lower health perception. The packaging textures only directly influence the salt perception. The rough/granular texture results in the highest salt perception, followed by the rough texture. The smooth texture results in the lowest salt perception. Interaction effects are found between the independent variables (packaging textures and salt levels in bouillon) and the salt perception and hedonic taste evaluation.

Conclusion

This research shows that packaging textures can influence the salt perception of the consumer. However, it appears that the amount of salt in a product plays a major role in this, a packaging texture can only affect salt perception when there is enough salt in a product. This research is of value for existing theoretical knowledge, in addition it offers valuable insights for multiple disciplines on how the taste of the consumer can be influenced by different textures. Furthermore, this research can serve as a starting point for further research into how healthy products, in particular with little salt, can be made more attractive for consumers.

Keywords

Design, texture, multisensory experience, sensory marketing, food experience, saltiness, health

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1. Introduction

Much research is currently being devoted to the eating habits and general lifestyle of the consumer. A large part of this research is towards reducing sodium (salt) intake, because this seems to be one of the most pressing health challenges. It turns out that the average European consumes more than twice the recommended daily amount of salt every day (Kloss, Meyer, Graeve, & Vetter, 2015). Excessive consumption of salt can result in negative health effects, such as high blood pressure and cardiovascular diseases (Kloss et al., 2015). The choice for unhealthy food can partly be explained by the 'health-pleasure trade off', consumers experience that healthy food is less tasty than unhealthy food, in addition, they believe that food cannot be made healthier without sacrificing part of the taste (Bialkova, Grunert, & Van Trijp, 2013). So, when purchasing food, consumers feel that they are faced with a choice between healthy and tasty. Although this effect is less prevalent than a few years ago, it is still strongly present when buying products where the sensory experience is the most important motivation for the purchase, such as snacks. This choice consideration often results in an unhealthy food choice (Bialkova et al., 2013; Jo, Jayson, & Lusk, 2018).

One way to reduce the salt intake can be through package design. Various studies have shown that people intuitively make connections between different sensory domains, this is called 'cross-modal correspondence' (Becker, Van Rompay, Schifferstein, & Galetzka, 2011). In addition, several studies have shown that the taste perception can be influenced by means of tactile stimuli on the package design. For example, Ngo, Misra and Spence (2011) and Zhang, Feick and Price (2006) have shown in their studies that bitterness is linked to angular packaging, whereas round packaging causes sweet and mild associations. Furthermore, Piqueras-Fiszman and Spence (2012) have shown that cookies from a rough packaging are perceived as harder and crisper than biscuits served from a package with a smooth surface.

In their study, Van Rompay and Groothedde (2019) have shown that a package with a rough, granular texture results in a higher salt perception, which means that less salt needs to be added to the products to experience the same salt perception. However, in their study it is not yet clear which design aspects are primarily responsible for the heightened saltiness perception. For example, it is possible that only the rough texture is responsible for the increased salt perception. On the other hand, it could also be the addition of granules that caused the effect. Therefore, in this study it will be investigated which texture results in a higher salt perception, a smooth texture, a rough texture or a rough/granular texture. It is expected that the rough/granular texture will result in the highest salt perception, because this texture most closely matches the texture of salt. The research question is as follows: *To what extent do different packaging textures influence the*

salt perception, hedonic taste evaluation and health perception of the consumer and to what extent does this influence depend on the amount of salt in a product?

This research is carried out using three 3D printed sample cups (further mentioned as: cups) with a smooth, rough and rough/granular texture. In these cups, bouillon with different salt levels is served. Minimum salt bouillon, medium salt bouillon and maximum salt bouillon are used. The bouillon is judged on its saltiness, hedonic taste and health perception. This research has a 3 (smooth vs. rough vs. rough/granular) x 3 (minimum salt vs. medium salt vs. maximum salt bouillon) experimental design.

Because of the limited research in the field of tactile stimuli and its influence on the total product evaluation of the consumer, this research is of value for existing theoretical knowledge. For example, a clear association between textures and salt perception has been found. The results of this study have a very high relevance for addressing the problem of excessive salt intake, as healthy products with little salt could possibly be made more attractive to the consumer through this research.

2. Theoretical framework

2.1. Product package and associations

Packaging plays a major role in the presentation of food products. Consumers use the characteristics of packaging, such as shapes, colors and materials, to form an impression of the content (Ares & Deliza, 2010). Various researchers have shown that people intuitively make connections between different sensory domains to evaluate the product, this is called 'cross-modal correspondence' (Becker et al., 2011). In the food industry, different cross-modal correspondences already have been found. For example, studies have shown that consumers associate taste with other sensory characteristics, such as colors (Piqueras-Fiszmann & Spence, 2012), sounds (Knöferle & Spence, 2012), shape (Velasco, Woods, Lui, & Spence, 2016) and texture (Ngo et al., 2011). For instance, Hine (1995) has shown that adding a small percentage of yellow (15%) on the green packaging of 7-Up cans causes the consumer to experience the taste as more lemony, even if the drink itself is not is manipulated. The results of these studies show that consumers use the symbolic meanings of the packaging to estimate their content. In this automatic process, consumers use implicit schemes where impressions derived from one source (e.g. package texture) form assumptions for following product impressions (e.g. taste) (Van Rompay, Finger, Saakes, & Fenko, 2017). These expectations are often formed by physical interactions. This has been demonstrated in, among others, the research by Becker et al. (2016), in which the respondents ate yogurt from an angular or round package. The results showed that yogurt from an angular package is perceived as more intense than the same yogurt served in a round package (Becker et al., 2016). This is because angular shapes give a more powerful and intense impression on the skin than round shapes. The powerful and intense impression of the angular shapes is transformed in the mind of the consumer by an implicit scheme to the association 'strong and intense'. This association is in turn transferred to the actual taste of the yogurt, resulting in a stronger and more intense taste. This means that consumers base their expectations regarding the taste of a product on the 'look and feel' of the product (Van Rompay et al., 2017). Because the impact of a multitude of packaging elements (e.g. used materials, colors) has been well established in the last few years, more and more manufacturers experiment with different packaging materials and surface textures. For example, soft drink manufacturers use a matte structure to give their drink a more masculine or rugged image. Unlike skin care brands, which present their products in a package with a soft structure to emphasize the softening or nourishing effects of the product (Van Rompay, Kramer, & Saakes, 2018).

2.2. The influences of tactile stimuli

Research on the influence of texture of materials on the evaluation of food and beverages and their taste is still limited, even though the consumer's sense of touch appears to play an important role in the purchase of products. The consumer receives a lot of information about the product through physical contact with the product, although they do not realize it themselves (Barnett-Cowan, 2010; Krishna &

Morrin, 2007). Spence and Gallace (2011) state that touch is related to the emotions of the consumer, which means that feeling a product and its packaging influences the expectations of the consumer. Schifferstein, Fenko, Desmet, Labbe and Martin (2013) show that this appears to be the case mainly in the first phase of the purchasing process, in this phase the consumer develops a feeling about the packaging and its contents. By touching the packaging, the consumer thinks that he can estimate the true taste of the product. The touch indirectly evokes memories of the taste of previously purchased food (Schifferstein et al., 2013). It is therefore possible to manipulate the expectations of the consumer by making smart use of tactile stimuli on the product packaging. The effects of various tactile stimuli have been demonstrated in, among others, the research by Van Rompay et al. (2017), using two 3D printed cups with different textures, a cup with angular surface patterns and a cup with round surface patterns. In this study, the respondents drank coffee and chocolate milk from the cups. The results showed that when an angular element is embedded in the surface structure of a cup, coffee tastes more bitter and intense. When a packaging with round shapes is used, a drink is experienced as sweeter and less intense (Van Rompay et al., 2017). Slocombe, Carmichael and Simner (2016) researched how the sour taste perception can be strengthened. In their study, the respondents ate of a smooth or rough plate. The results showed that food is perceived as more sour when served on a rough plate than when served on a smooth plate. Furthermore, Tu, Yang and Ma (2015) have shown that a glass cup, in contrast to a plastic cup, produces a sweeter taste experience. Such findings show that there is great potential in influencing food experiences by adjusting the tactile properties of the packaging.

Although different cross-model correspondences have already been established between different tastes and tactile stimuli, a number of areas are not yet sufficiently covered. For example, a relation that hardly has been studied, is the relation between tactile stimuli and salt perception. One of the first studies into this relation was conducted by Van Rompay and Groothedde (2019), they have shown that a rough, granular structure leads to a higher salt perception than a smooth structure. In their research, the respondents ate salt-free, medium salt or maximum salt chips, while they had a smooth or rough, granular package in their hands. After tasting the chips, the respondents had to assess the chips on saltiness and related product evaluations (such as tastiness). The results showed that the medium and maximum salt chips were perceived as saltier when the respondents were holding the rough, granular package in their hands, compared to when they were holding the smooth package. The rough, granular package did not influence the salt perception when there was no salt in the chips. This means that to influence the salt-perception, there must be at least a little salt in the product (Van Rompay & Groothedde, 2019). Therefore, in this study use will be made of minimum salt bouillon, which contains a small amount of salt, medium salt bouillon and maximum salt bouillon. Although a clear connection between a rough, granular texture and salt perception has been demonstrated in the study of Van Rompay and Groothedde (2019), it is still unclear which design aspects are primarily responsible for this effect. The rough, granular package has various aspects that could have affected the salt perception. For example, only the rough feel, without the addition of grains, could have been

sufficient to increase salt perception. On the other hand, it could also be that the addition of grains to the rough texture was responsible for the increased salt perception, since the gains may remind the respondents of salt. Therefore, in this study use will be made of a smooth cup, a rough cup and a rough/granular cup. There is no cup with just a granular texture, because this texture automatically has a rough feel.

In line with the above mentioned literature, the following hypotheses have been drawn up:
H1a: The cup with the rough/granular texture will, compared to both the smooth cup and rough cup, result in a saltier taste perception.
H1b: The cup with the rough texture will, compared to the cup with the smooth texture, result in a saltier taste perception.

2.3.   Expectation disconfirmation theory

Although various effects of tactile stimuli on taste perception have been shown, it appears that the effects of tactile stimuli can also tilt when the expectations and actual experience are too far apart, this is called 'the expectation disconfirmation theory' (Bhattacherjee & Permkumar, 2004). This effect can be both positive and negative and has been demonstrated by, among others, Verastegui-Tena, Van Trijp, & Piqueras-Fiszman (2019). In their study, where the respondents had to drink fruit juice or vegetable juice, the expectations of the respondents were manipulated in advance by showing them a picture of an ingredient and then providing them with a juice that was in line with their expectations or a juice that was very different from their expectations. The results showed that, although the fruit juices were identical in both conditions, the fruit juice was experienced as sweeter, less salty, less bitter and tastier when a vegetable taste was expected than when a matching fruit taste was expected. In line with these findings, the vegetable juice, which was also identical in both conditions, was experienced as less sweet, more salty, more bitter and less tasty when a fruit flavor was expected than when the matching vegetable flavor was expected (Verastegui-Tena et al., 2019). Moreover, in the study by Schwarz and Bless (1992), respondents were instructed to estimate how many calories were in certain products. The products were all placed on a 'low-calorie breakfast products' shelf. A rusk that stood between the low-calorie breakfast products was assessed by the respondents as a low-calorie product. This is because the respondents' actual experience does not differ much from their expectations. The characteristics of rusk matches the characteristics of the other products on the 'low-calorie breakfast' shelf and rusk can therefore be expected on the concerning shelf. A cookie that lies between the low-calorie breakfast products, on the other hand, was assessed as incredibly high in calories. This is due to the large difference between the characteristics of cookies and low-calorie breakfast products. In this condition, the actual experience does not match the expectations of the respondents, so the cookie is estimated to be higher in calories than it actually is (Schwarz & Bless, 1922). In addition, Yeomans, Chambers, Blumenthal and Blake (2008) have clearly demonstrated this

effect. Their study shows that when consumers see an ice cream label that raises high expectations of a sweet taste, but subsequently taste ice cream with a salty taste, the sweetness ratings decrease (Yeomans et al., 2008). Furthermore, the research by Van Rompay and Groothedde (2019) shows that the rough, granular structure only affects the salty taste perception in a positive way when the respondents ate chips with salt. The effect did not occur when the respondents ate salt-free chips. This effect arises because the actual taste experience deviates too much from the expectations. When respondents hold the rough, granular packaging, they expect a product with a high salt content, because the structure of the packaging reminds them of salt. When the actual taste of the product deviates considerably from the expected taste, because there is no or very little salt in the product, the perceived taste is enhanced by the discrepancy with the expected taste. As a result, the respondents experience the taste of the product as more bland, compared to the situation when expectations are in line with the experienced taste. If a consumer has a similar, negative experience, it can lead to long-term negative consequences for the perception and consumption of the product and its brand (Bhattacherjee & Permkumar, 2004; Spence, 2012). So when bouillon with little salt is served in this study, it can be expected that, due to the expectation disconfirmation, this bouillon is perceived as less salty in a packaging that would increase salt perception than in a regular package, due to increased saltiness expectations. This is because of the big discrepancy between the expected taste and the actual taste.

Because of the expectation disconfirmation theory, it is necessary to apply nuances to the previously prepared hypotheses. As previously indicated, it is expected that holding the rough/granular cup will result in the highest salt expectancy. However, in line with the expectation disconfirmation theory, this effect will probably tilt when the participants taste the minimum salt bouillon, since the discrepancy between the expected taste and the actual taste is too big. This effect is also expected when serving minimum salt bouillon in a rough cup. However, this effect is not expected to be as strong as when using the rough/granular cup, since the salt expectation is lower when touching the rough cup than when touching the rough/granular cup. Therefore, the following hypothesis has been drawn up:

H1c: The minimum salt bouillon will result in the lowest salt perception when served in the rough/granular cup, followed by the rough cup, the smooth cup will result in the highest salt perception.

2.4. Unhealthy is tasty

Stimulating consumers to eat healthier appears to be a difficult task. Many consumers perceive unhealthy food as tastier than healthy food. The consumer feels like a good taste and healthy food are incompatible, so when purchasing food, they feel that they are faced with a choice between healthy and tasty. This is called the health-pleasure trade-off (Bialkova et al., 2013). Although this effect has

been slowly fading over the past few years, it is still strongly present when buying products where the sensory experience is the most important motivation for the purchase (Bialkova et al., 2013; Jo et al., 2018). The health-pleasure trade-off results in consumers often making unhealthy food choices. This can be seen, for example, in the amount of salt consumed. The recommended daily amount of salt is a maximum of 5 grams, but the average European consumes 10 grams of salt per day (Kloss et al., 2015). Excessive consumption of salt can lead to various negative health effects, such as cardiovascular disease, it is therefore important that the daily salt intake is reduced (Kloss et al., 2015). In this study it is expected that the hedonic taste evaluation and health perception will be influenced by the different salt levels in bouillon and the different textures on the serving cup. When consumers expect that the content is salty, they also expect it to be unhealthy. Unhealthy products, in turn, are expected to be tasty. The hedonic taste evaluation translates into how tasty the consumer experiences the bouillon.

Based on the mentioned literature, the following hypotheses have been drawn up:

H2a: The maximum salt bouillon will, compared to the medium and minimum salt bouillon, result in a higher hedonic taste evaluation and a lower health perception.

H2b: The medium salt bouillon will, compared to the minimum salt bouillon, result in a higher hedonic taste evaluation and a lower health perception.

H2c: The cup with the rough/granular texture will, compared to the cup with the smooth and rough texture, result in a higher hedonic taste evaluation and a lower health perception.

H2d: The cup with the rough texture will, compared to the cup with the smooth texture, result in a higher hedonic taste evaluation and a lower health perception.

However, given the expectation disconfirmation theory, it is expected that H2c and H2d are not valid when minimum salt bouillon is served. Hence, the following hypothesis has been drawn up:

H2e: The minimum salt bouillon will result in the lowest hedonic taste evaluation and highest health perception when served in the rough/granular cup, followed by the rough cup, the smooth cup will result in the highest salt perception.

2.5.   Research model

In this research, the effects of different package textures and salt levels in bouillon on the salt perception, hedonic taste evaluation and health perception are investigated. In addition to these main effects, the interaction effect of the packaging textures together with the different salt levels in bouillon on the salt perception, hedonic taste evaluation and health perception will also be examined. To test the hypotheses, a 3 (package texture: smooth vs. rough vs. rough/granular) x 3 (product type: minimum salt bouillon vs. medium salt bouillon vs. maximum salt bouillon) design has been drawn up. Based on the literature and the established hypotheses, a research model has been developed, shown in figure 1.
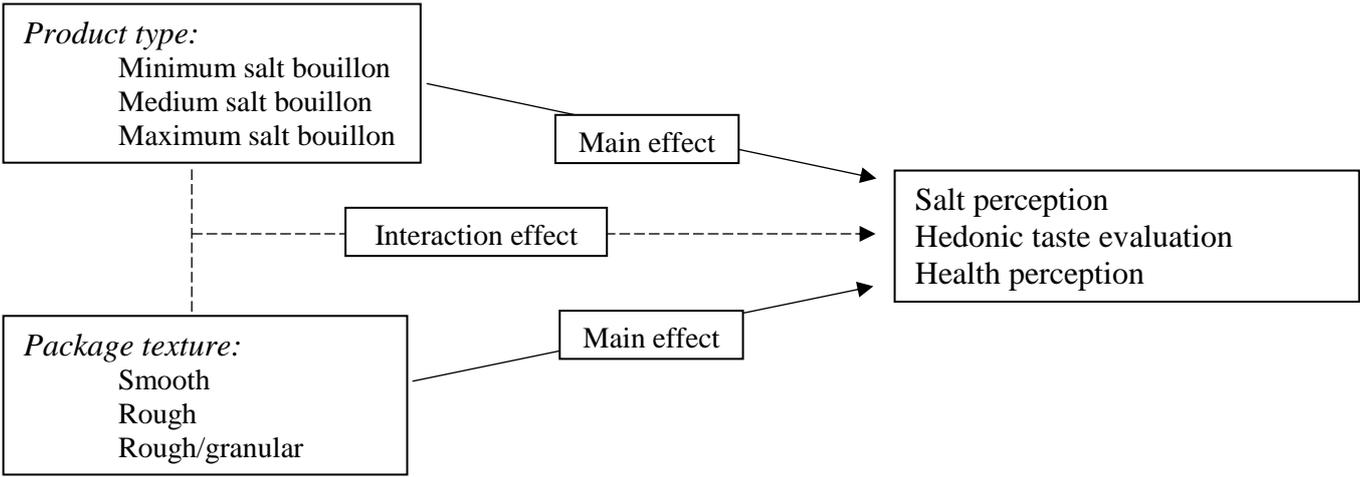
Figure 1: Research model of the variables

3. Pre-test

3.1. Pre-test 1

3.1.1. Package design

A pre-test was needed to investigate whether the created packages were suitable for the main study. It is important that the packaging is perceived as realistic. If the packaging is perceived as unrealistic, it can negatively influence the reliability of the research. It is also important that the created textures are experienced as intended, so the smooth texture as smooth, the rough texture as rough and so on. The materials are shown in figure 2.

Figure 2: The 3D printed cups (smooth vs. rough vs. rough/granular)

3.1.2. Method

To determine whether the materials are realistic, the respondents felt and looked at the three different cups that would be used in the main study. These cups differ in texture, there is a cup with a smooth texture, a rough texture and a rough/granular texture. The realism of the cups has been tested by means of a questionnaire.

A total of 15 respondents took part in this pre-test, including 7 men and 8 women. The age of the respondents varied between 23 and 70 years. The questionnaire started with a short introduction about the pre-test. Subsequently, the evaluation of the different textures on the cups was measured by four word combinations, developed by Osgood, Suci and Tanenbaum (1957). Furthermore, the realism of the cups was measured by means of the four items: 'This cup is suitable for drinking', 'This cup feels nice', 'It is realistic to drink from this cup' and 'This cup fits the product type'. These items were measured on a five-point Likert scale. Finally, the participants were asked if they had any suggestions for adjusting the cups, so that they are even better suitable for drinking. The questionnaire can be found in Appendix 1.

3.1.3. Results

The average score and standard deviation are calculated to investigate whether the three serving cups are realistic. The averages show to what extent the respondents agree with the statements. The

statements that were used form a reliable scale and are all formulated positively in the pre-test. Table 1 shows the average scores on the realism scale of the three cups. Cup 1 is the smooth cup, cup 2 the rough cup and cup 3 is the rough/granular cup. The results show that cup 1 (M=4.85, SD=0.31), cup 2 (M=4.75, SD=0.37) and cup 3 (M=4.78, SD=0.34) have a high average, which means that the cups are experienced as realistic. No significant differences were found between the averages (p>0.10).

Table 1: Average score realism 3D printed cups

Variables	N	N-items	α	Average score	SD
Realism cup 1 [a]	15	4	0.872	4.85	0.31
Realism cup 2 [a]	15	4	0.841	4.75	0.37
Realism cup 3 [a]	15	4	0.829	4.78	0.34

a) *5 point Likert scale (1=totally disagree / 5=totally agree)*

Table 2 shows the average scores of the tactile experiences of the respondents. The four items that are used form a reliable scale. The lower the score, the rougher and granular the texture was experienced. The higher the score, the smoother the texture was experienced. Cup 1 (M=4.90, SD=0.12) is perceived as smoother than cup 2 (M=3.89, SD=0.34, p<0.01) and cup 3 (M=2.27, SD=0.24, p<0.01). Cup 3 (M=2.27, SD=0.24) is experienced as rougher and granular than cup 1 (M=4.90, SD=0.12, p<0.01) and cup 2 (M=3.89, SD=0.34, p<0.01). Looking only at the roughness, it appears that there are no significant differences between the averages of cup 2 (M=1.67, SD=0.62) and cup 3 (M=1.40, SD=0.51, p>0.10). This means that these cups are experienced as almost equally rough. The results show that the cups are experienced as intended. Cup 1 will be used as the smooth cup, cup 2 as the rough cup and cup 3 as the rough/granular cup.

Table 2: Average score texture 3D printed cups

Variables	N	N-items	α	Average score	SD
Texture cup 1 [a]	15	4	0.739	4.90	0.12
Texture cup 2 [a]	15	4	0.739	3.89	0.34
Texture cup 3 [a]	15	4	0.739	2.27	0.24

a) *5 point bipolar scale (rough/smooth, granular/even, hard/soft, stingy/smooth)*

Many respondents did not answer the last question, which asked how the cups could be adjusted to make them more suitable for drinking. Nevertheless, a number of respondents did make suggestions, such as 'use of color' and 'add a handle'. These suggestions have not been applied to the material, because the respondents in the main study could be influenced by this. In addition, it is not possible to give the cup a firm handle using a 3D printer. The materials retain in their shape and neutral color.

3.2. Pre-test 2

3.2.1. Salt levels in bouillon

A second pre-test was needed to select three suitable salt levels in bouillon for the main study. The purpose of this pre-test was to find three salt levels that were experienced as minimum salt, medium salt and maximum salt. In this pre-test, use was made of 'Maggi vegetable bouillon' and 'Maggi vegetable bouillon less salt'. The only difference between these two bouillons is the amount of salt (0,6 g. per 100 ml vs. 0,1 g. per 100 ml). In addition, three other salt levels were created by adding salt to the two aforementioned bouillons. This resulted in five different salt levels in the vegetable bouillon (0,1 g. per 100 ml, 0,3 g. per 100 ml, 0,5 g. per 100 ml, 0,6 g. per 100 ml and 0,8 g. per 100 ml).

3.2.2. Method

To find three suitable salt levels, the respondents tasted all five bouillons. The salt perception of the bouillon was measured with the statement 'This product tastes salty'. In addition to salt perception, the taste experience was measured with the statement 'This product is tasty'. Also, it was measured whether the respondents would buy the bouillon in the store with the statement 'I would buy this product in the store'. The statements were measured on a seven-point Likert scale. A total of 15 respondents participated in this pre-test, of which 7 were men and 8 were woman. The age of the respondent varied between 23 and 70 years. The questionnaire started with a short introduction about the pre-test. Subsequently, the salt perception and taste evaluation were measured by means of a short questionnaire. All statements used were formulated positively. The questionnaire can be found in Appendix 2.

3.2.3. Results

The average scores and standard deviations are calculated to investigate to what extend the bouillon is experienced as salty and tasty. Table 3 shows the average salt perception scores per salt level. The table shows that salt level 1 (0,1 g. salt per 100 ml) (M=2.07, SD=0.70) has the lowest average score, which means that this salt level is experienced as the least salty. Salt level 5 (0,8 g. salt per 100 ml) (M=6.80, SD=0.41) has the highest average, which means that this salt level is experienced as the most salty. Salt level 4 (0,6 g. salt per 100 ml) (M=6.00, SD=0.76) is also experienced as very salt. The average of salt level 2 (0,3 g. salt per 100 ml) (M=4.07, SD=0.70) is between the averages of the least salty bouillon and most salty bouillon, which means that salt level 2 is experienced as medium salt.

Table 3: Average score salt perception per salt level

Variables	N	Average score	SD
Salt level 1 [a)]	15	2.07	0.70
Salt level 2 [a)]	15	4.07	0.70
Salt level 3 [a)]	15	5.47	0.52
Salt level 4 [a)]	15	6.00	0.76
Salt level 5 [a)]	15	6.80	0.41

a) *7 point Likert scale (1=totally disagree / 7= totally agree)*

Table 4 shows the average scores of the taste evaluation per salt level. This shows that salt level 5 (M=4.40, SD= 2.03) is perceived as the least tasty, the average of this salt level also deviates significantly from the other salt levels ($p<0.05$). Salt level 5 is therefore excluded from the main study. Salt level 4 (M=6.00, SD=0.76) is considered the most salty after salt level 5 and will therefore be used as the maximum salt bouillon in the main study. No significant differences ($p>0.10$) were found between the means of salt level 1 (M=5.07, SD=1.01), salt level 2 (M=5.93, SD=1.16) and salt level 4 (M=6.27, SD=0.70). Moreover, no significant differences were found with regard to the purchase intention in stores between salt level 1, salt level 2 and salt level 4 ($p>0.10$).

Table 4: Average score taste evaluation per salt level

Variables	N	Average score	SD
Salt level 1 [a)]	15	5.07	1.01
Salt level 2 [a)]	15	5.93	1.16
Salt level 3 [a)]	15	6.27	0.59
Salt level 4 [a)]	15	6.27	0.70
Salt level 5 [a)]	15	4.40	2.03

a) *7 point Likert scale (1=totally disagree / 7= totally agree)*

4. Main study

4.1. Experimental design

The starting point of this study was a serving package that could be used to drink soup or bouillon. To test the composed hypotheses, a 3 (smooth vs. rough vs. rough/granular texture) x 3 (minimum salt vs. medium salt vs. maximum salt bouillon) experimental design was prepared. In this study, the textures of the cups and the different salt levels in bouillon were the independent variables. The dependent variables were the salt perception, hedonic taste evaluation and the health perception. For creating the three cups, a 3D printer was used. A smooth cup, a rough cup and a rough/granular cup were printed. When it comes to the rough cup and the rough/granular cup, an attempt was made to project the feel of salt onto the cup. The smooth texture was chosen, because this texture is already widely used for serving packaging. The rough and rough/granular cup were expected to generate an association with salt, thereby increasing the salt perception. The salt levels were chosen using a pre-test. In this main study a minimum salt, medium salt and maximum salt bouillon were used. The nine conditions of this study are shown in table 5. The influence of the different textures and the different salt levels in bouillon on the salt perception, hedonic taste evaluation and health perception were investigated by means of an experiment. This experiment consisted of making physical contact with the cups and then tasting the bouillon.

Table 5: Nine conditions in the main study

	Minimum salt bouillon	Medium salt bouillon	Maximum salt bouillon
Smooth texture	1	2	3
Rough texture	4	5	6
Rough/granular texture	7	8	9

4.2. Participants

Both men and women were approached during this study. The age of the respondents varied between 18 and 92 years. There was no maximum age associated with this study, since any age group can drink and buy bouillon. The minimum age to participate in this study was 18 years. Furthermore, people were excluded from the study if they were on a low-salt diet. Based on these criteria, three people were excluded from the study.

The total number of respondents who participated in this study is 270. The average age was 46.00 (SD=20.49) years. For each condition, 30 participants were used. Condition 6 had the highest age average (M=49.43, SD=20.31) and condition 5 had the lowest age average (M=41.90, SD=17.35). No significant differences were found between the age averages in the nine different conditions. A total of 136 men and 134 women participated in this study. No significant differences were found

between the gender of the participants between all nine conditions. The gender and average age of the respondents are shown in table 6.

Table 6: Demographic characteristics of the respondents per condition

Condition	N	Age		Gender	
		M	*SD*	**Male**	**Female**
1	30	45.90	20.01	16	14
2	30	46.17	21.83	14	16
3	30	46.33	21.12	14	16
4	30	46.40	22.50	16	14
5	30	41.90	17.35	15	15
6	30	49.43	20.31	14	16
7	30	45.93	21.09	15	15
8	30	45.97	21.53	17	13
9	30	45.97	20.24	15	15

4.3. Procedure

The respondents were approached and asked to participate in the main study at a supermarket in Vaassen. When approached, respondents were asked whether they were sensitive to salt or whether they were on a low-salt diet. If this was the case, they were excluded from the study. When the respondents agreed to participate in the study, they first received a brief introduction about the study. The anonymity and possibility of stopping the participation at any time, was also mentioned. After the respondents agreed with the informed consent, the respondents received one of the three cups containing one of the three bouillons. The respondents were randomly assigned to the various conditions. The respondents were asked to taste some of the bouillon and then complete a questionnaire about it. Completing the questionnaire took 5 to 10 minutes of the respondent's time. After completing the questionnaire, the respondent returned it to the researcher. After completing the survey, the respondents were thanked for their participation.

4.4. Measurement

The questionnaire used in the main study was intended to measure the effect of the independent variables (packaging texture, salt level in bouillon) on the dependent variables (salt perception, hedonic taste evaluation, health perception). The questionnaire used in this main study is attached in Appendix 3. In this study, a 0.70 Cronbach's Alpha was used as a threshold for a reliable scale. A Cronbach's Alpha higher than 0.70 means that the items in the scale all measure the same.

4.4.1. Salt perception

The salt perception was measured with the statement 'This product tastes salty'. Since this variable was only measured with one item, no Cronbach's Alpha can be measured.

4.4.2. Hedonic taste evaluation

The hedonic taste evaluation was measured with the items 'This product is delicious', 'I like the taste of this product', 'The taste of this product is how I feel it should be' and 'The taste of this product appeals to me to'. The Cronbach's Alpha of this scale is 0.98.

4.4.3. Health perception

The construct health perception was measured with the items 'I think this product is high in calories', 'I expect this product is high in fat', 'This product tastes healthy' and 'I expect this product to be natural'. Since the statements 'I think this product contains a lot of calories' and 'I expect this product contains a lot of fat' were both formulated negatively, they have been reversed coded. The Cronbach's Alpha of this scale is 0.96.

4.4.4. Other variables

In addition to the aforementioned variables, a few others were measured. First of all the psychological effects of consumption, in which it was measured whether the bouillon gave an energy boost according to the respondent. This variable was measured with the items 'To what extent do you feel refreshed after drinking this bouillon', 'To what extent do you get energy from this bouillon', 'To what extent do you feel that this bouillon gets you going again' and 'To what extend do you feel recovered after drinking this bouillon'. The Cronbach's Alpha of this scale is 0.76. In addition, the purchase intention was measured to see whether the respondents would buy the bouillon. This construct was measured with the items 'When I am in the supermarket to buy bouillon, I would consider this bouillon', 'If this bouillon is in the supermarket, I would like to try this bouillon' and 'Now that I have tasted this bouillon, I am curious about this bouillon'. De Cronbach's Alpha of the purchase intention scale is 0.98. Finally, the taste intensity of the bouillon was measured, whereby the taste of the bouillon was evaluated by the respondents with the statements 'This bouillon tastes intense', 'This bouillon tastes savory' and 'This bouillon tastes powerful'. The Cronbach's Alpha of this scale is 0.60, which is too low. Even with two items it is not possible to make a reliable scale, therefore it has been decided to measure the taste intensity with only the item ´This bouillon tastes intense´.

5. Results

5.1. Introduction

The relevant results of the main study are explained in more detail in this chapter. The results were obtained by performing ANOVA's for the hypothesized effects. Table 7 shows the results of the ANOVA's.

Table 7: Main and interaction effects

Independent variables	Dependent variables	*F*	*p*
Salt levels	Salt perception	881.57	0.000
Texture	Salt perception	37.31	0.000
Salt levels*Texture	Salt perception	30.19	0.000
Salt levels	Hedonic taste evaluation	401.81	0.000
Texture	Hedonic taste evaluation	1.81	0.165
Salt levels*Texture	Hedonic taste evaluation	5.30	0.000
Salt levels	Health perception	389.93	0.000
Texture	Health perception	0.02	0.982
Salt levels*Texture	Health perception	0.02	0.999
Salt levels	Purchase intention	328.64	0.000
Texture	Purchase intention	4.83	0.009
Salt levels*Texture	Purchase intention	5.97	0.000
Salt levels	Psychological effects	256.37	0.000
Texture	Psychological effects	1.57	0.211
Salt levels*Texture	Psychological effects	0.30	0.876
Salt levels	Taste intensity	1241.46	0.000
Texture	Taste intensity	1.389	0.251
Salt levels*Texture	Taste intensity	0.904	0.462

5.2. Salt perception

To discover which salt level and which packaging texture result in a higher salt perception an ANOVA was performed. First, it appears that the different salt levels significantly influence the salt perception ($F_{(2, 261)} = 881.57$, $p<0.001$, $\eta^2=0.9$). The Bonferroni test shows that the maximum salt bouillon (*M*=5.84, *SD*=0.83) is experienced as significantly saltier than the minimum salt bouillon (*M*=1.90, *SD*=0.69, $p<0.001$) and the medium salt bouillon (*M*=4.74, *SD*=1.00, $p<0.001$). In addition, the medium salt bouillon (*M*=4.74, *SD*=1.00) is experienced as significantly saltier than the minimum salt bouillon (*M*=1.90, *SD*=0.69, $p<0.001$).

The packaging texture also appears to have a significant influence on salt perception ($F_{(2, 261)} = 37.31$, $p < 0.001$, $\eta^2 = 0.2$). The Bonferroni test shows that the rough/granular texture ($M=4.56$, $SD=2.27$) results in a higher salt perception than the smooth texture ($M=3.72$, $SD=1.45$, $p<0.001$) and the rough texture ($M=4.21$, $SD=1.72$, $p=0.001$). In addition, the rough texture ($M=4.21$, $SD=1.72$) results in a significantly higher salt perception than the smooth texture ($M=3.72$, $SD=1.45$, $p<0.001$).

There also appears to be a significant interaction effect between the packaging textures and the different salt levels on the salt perception ($F_{(4, 261)} = 12.77$, $p<0.01$, $\eta^2 = 0.3$). However, the Pairwise Comparisons analysis shows that not all effects are significant. It appears that there are no significant differences between minimum salt bouillon in combination with the smooth texture ($M=2.13$, $SD=0.68$) and minimum salt bouillon in combination with the rough texture ($M=2.07$, $SD=0.64$, $p=0.692$). When minimum salt bouillon is served, the smooth texture ($M=2.13$, $SD=0.12$) results in a significantly higher salt perception than the rough/granular texture ($M=1.50$, $SD=0.12$, $p<0.001$). When medium salt bouillon is served, the rough/granular texture ($M=5.63$, $SD=0.12$) results in a significantly higher salt perception than the smooth texture ($M=3.83$, $SD=0.12$, $p<0.001$) and the rough texture ($M=4.77$, $SD=0.12$, $p=0.001$). Furthermore, the medium salt bouillon in combination with the rough texture ($M=4.77$, $SD=0.12$) results in a significantly higher salt perception than the medium salt bouillon in combination with the smooth texture ($M=3.83$, $SD=0.12$, $p<0.001$). Also, when maximum salt bouillon is served, the rough/granular texture ($M=6.53$, $SD=0.12$) results in a significantly higher salt perception than the smooth texture ($M=5.20$, $SD=0.12$, $p<0.001$) and the rough texture ($M=5.80$, $SD=0.12$, $p<0.001$). Moreover, the maximum salt bouillon in combination with the rough texture ($M=5.80$, $SD=0.12$) results in a significantly higher salt perception than the maximum salt bouillon in combination with the smooth texture ($M=5.20$, $SD=0.12$, $p<0.001$). Figure 3 shows the effects of different salt levels and packaging textures on salt perception.
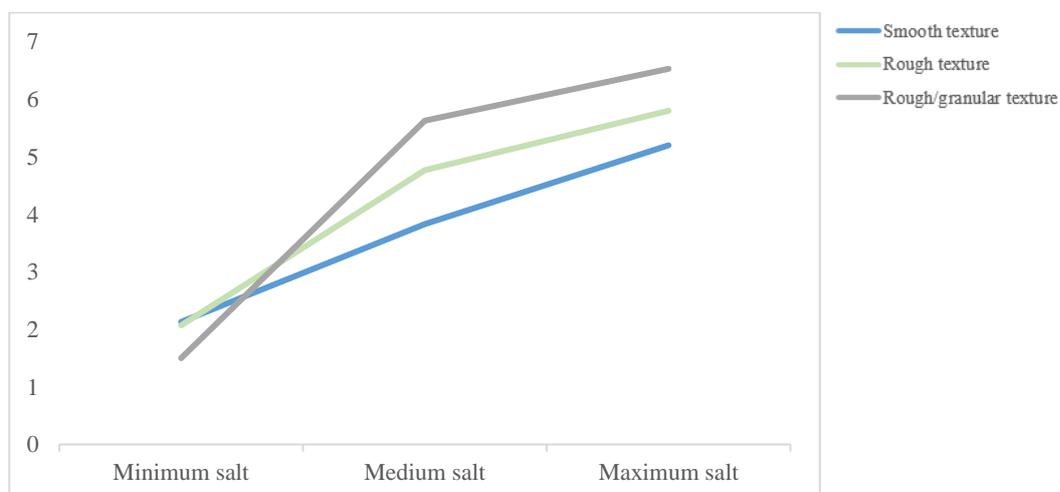

Figure 3: Effect of different salt levels and packaging textures on salt perception

5.3.   Hedonic taste evaluation

Various interesting results were also found in research into the effect of different salt levels and packaging textures on the hedonic taste evaluation. First, it appears that the different salt levels significantly influence the hedonic taste evaluation ($F_{(2, 261)} = 401.81$, $p<0.001$, $\eta^2=0.8$). The Bonferroni test shows that the maximum salt bouillon ($M=5.73$, $SD=0.87$) results in a significantly higher hedonic taste evaluation than the minimum salt bouillon ($M=2.12$, $SD=1.11$, $p<0.001$) and the medium salt bouillon ($M=4.71$, $SD=0.70$, $p<0.001$). In addition, it appears that the medium salt bouillon ($M=4.71$, $SD=0.70$) results in a higher hedonic taste evaluation than the minimum salt bouillon ($M=2.12$, $SD=1.11$, $p<0.001$). The effect of the packaging textures on the hedonic taste evaluation appears not to be significant ($F_{(2, 261)} = 1.81$, $p=0.165$).

The interaction effect between the packaging textures and the salt levels on the hedonic taste evaluation, however, appears to be significant ($F_{(4, 261)} = 5.30$, $p<0.001$, $\eta^2=0.8$). The Pairwise Comparisons analysis shows that this interaction effect is only significant when minimum salt bouillon is used. The smooth texture with minimum salt bouillon ($M=2.71$, $SD=0.16$) results in a significantly higher hedonic taste evaluation than the rough texture with minimum salt bouillon ($M=2.00$, $SD=0.16$, $p=0.02$) and the rough/granular texture with minimum salt bouillon ($M=1.64$, $SD=0.16$, p<0.001). There appears to be no significant interaction effect between the rough texture with minimum salt bouillon ($M=2.00$, $SD=0.16$) and the rough/granular texture with minimum salt bouillon ($M=1.64$, $SD=0.16$, $p=0.117$). Figure 4 shows the effects of the different salt levels and packaging textures on the hedonic taste evaluation.
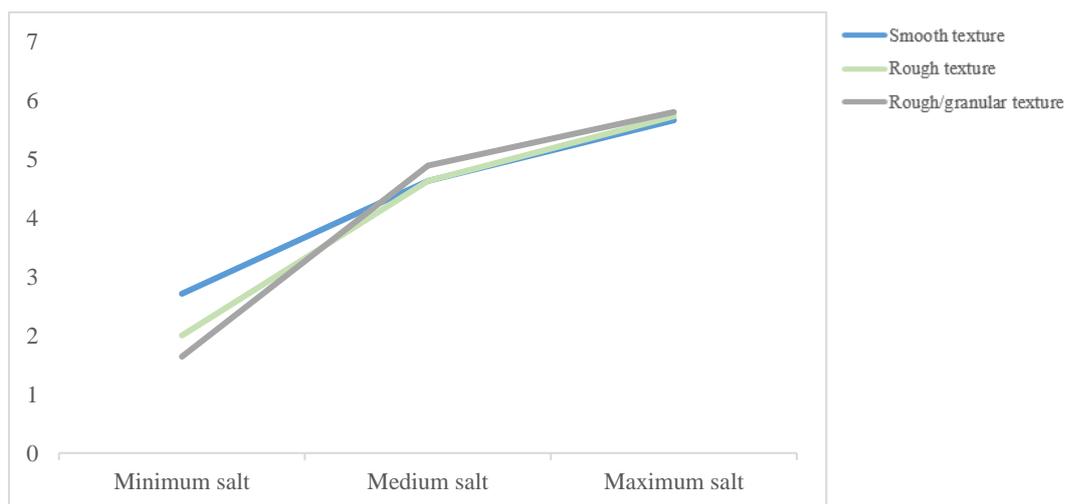

Figure 4: Effect of different salt levels and packaging textures on hedonic taste evaluation

5.4. Health perception

The effects of salt levels and packaging textures on health perception were also measured. It appears that only the different salt levels have a significant effect on health perception (F (2, 261) = 237.61, $p<0.001$, $\eta^2=0.7$). The Bonferroni test shows that the maximum salt bouillon ($M=2.84$, $SD=0.85$) results in a significantly lower health perception than the minimum salt bouillon ($M=6.04$, $SD=0.57$, p>0.001) and the medium salt bouillon ($M=3.96$, $SD=0.86$, $p<0.001$). Furthermore, it appears that the medium salt bouillon ($M=3.96$, $SD=0.86$) results in a significantly lower health perception than minimum salt bouillon ($M=6.04$, $SD=0.57$, $p>0.001$). No main effect was found between the packaging textures and the health perception (F (2, 261) = 0.019, $p=0.982$). Moreover, no interaction effect was found between the packaging textures and salt levels on the health perception (F (4, 261) = 0.23, $p=0.999$).

5.5. Purchase intention

The effects of salt levels and packaging textures on the purchase intention were also measured. First of all, it appears that the different salt levels significantly influence the purchase intention (F (2, 261) = 328.64, $p<0.001$, $\eta^2=0.7$). The Bonferroni test shows that the maximum salt bouillon ($M=5.69$, $SD=0.97$) results in a significantly higher purchase intention than the minimum salt bouillon ($M=2.13$, $SD=1.12$, $p<0.001$) and the medium salt bouillon ($M=4.92$, $SD=0.98$, $p<0.001$). The medium salt bouillon ($M=4.92$, $SD=0.98$) results in a significantly higher purchase intention than the minimum salt bouillon ($M=2.13$, $SD=1.12$, $p<0.001$).

The packaging textures also appears to have a significant effect on the purchase intention (F (2, 261) = 4.83, $p=0.009$, $\eta^2=0.04$). The Bonferroni test shows that the smooth texture ($M=3.99$, $SD=1.79$) results in a lower purchase intention than the rough texture ($M=4.39$, $SD=1.80$, $p=0.02$) and the rough/granular texture ($M=4.37$, $SD=1.93$, $p=0.026$). No further significant effects were found among the packaging textures.

However, there appears to be an interaction effect between the packaging textures and the salt levels on the purchase intention (F (4, 261) = 5.97, $p<0.001$, $\eta^2=0.08$). The Pairwise Comparisons analysis shows that the smooth texture with medium salt bouillon ($M=4.18$, $SD=1.07$) results in a lower purchase intention than the rough texture with medium salt bouillon ($M=5.28$, $SD=0.76$, $p<0.001$) and the rough/granular texture with medium salt bouillon ($M=5.30$, $SD=0.63$, $p<0.001$). In addition, the smooth texture with maximum salt bouillon ($M=5.46$, $SD=1.09$) result in a significantly lower purchase intention than the rough/granular texture with maximum salt bouillon ($M=5.96$, $SD=0.58$, $p=0.49$). Further inspection of the interaction shows that the smooth texture with the minimum salt bouillon ($M=2.32$, $SD=1.54$) results in a marginally significantly higher purchase intention than the rough/granular texture with minimal salt bouillon ($M=1.86$, $SD=0.79$, $p=0.066$). Figure 5 shows the effects of the different salt levels and the packaging textures on the purchase intention.
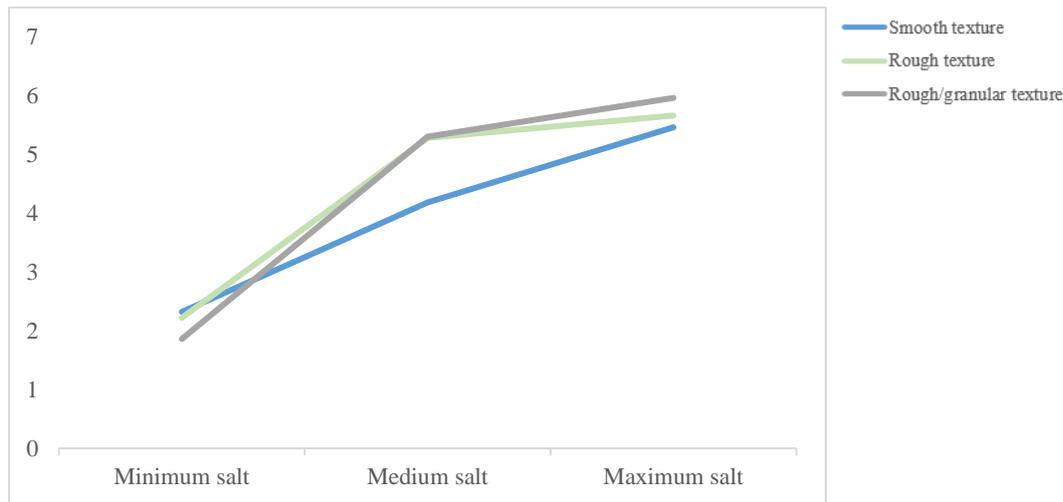
Figure 5: Effect of different salt levels and packaging textures on purchase intention

5.6. Psychological effects of consumption

The effects of salt levels and packaging textures on the psychological effect of consumption were also measured. It appears that only the different salt levels have a significant effect on the psychological effects of consumption ($F (2, 261) = 256.37$, $p<0.001$, $\eta^2=0.7$). The Bonferroni test shows that the maximum salt bouillon (*M*=5.16, *SD*=0.67) results in significantly higher psychological effects than the minimum salt bouillon (*M*=3.00, *SD*=0.61, *p*<0.001) and the medium salt bouillon (*M*=4.38, *SD*=0.66, *p*<0.001). Furthermore, the medium salt bouillon (*M*=4.38, *SD*=0.66) results in significantly higher psychological effects than the minimum salt bouillon (*M*=3.00, *SD*=0.61, *p*<0.001). No main effect was found between the packaging textures and psychological effects of consumption ($F (2, 261) = 1.57$, *p*=0.211). Moreover, no interaction effect was found between the packaging textures and salt levels on the psychological effects of consumption ($F (4, 261) = 0.30$, *p*=0.876).

5.7. Taste intensity

One significant effect was found in research into the effects of salt levels and packaging textures on the taste intensity. It appears that the salt levels have a significant effect on the taste intensity ($F (2, 261) = 1241.46$, *p*<0.000, $\eta^2=0.9$). The Bonferroni test shows that the maximum salt bouillon (*M*=6.22, *SD*=0.73) results in a significantly higher taste intensity than the minimum salt bouillon (*M*=1.41, *SD*=0.49, *p*<0.000) and the medium salt bouillon (*M*=5.09, *SD*=0.77, *p*<0.000). It also appears that the medium salt bouillon (*M*=5.09, *SD*=0.77) results in a significantly higher taste intensity than the minimum salt bouillon (*M*=1.41, *SD*=0.49, *p*<0.000). No main effect was found between the packaging textures and the taste intensity ($F (2, 261) = 1.39$, *p*=0.251. Furthermore, no interaction effect was found between the packaging textures and salt levels on the taste intensity ($F (4 261) = 0.90$, *p*=0.462).

6. Discussion

6.1. Discussion of the results

The aim of this study was to measure the influence of different salt levels in bouillon and packaging textures on the salt perception, hedonic taste evaluation and health perception. Although not all of the formulated hypotheses have been confirmed, various interesting results have been found.

First, it appears that the different salt levels in bouillon influence salt perception. The maximum salt bouillon is experienced as the most salty and the minimum salt bouillon is experienced as the least salty. This is not a surprising result, since the maximum salt bouillon contains the most salt and the minimum salt bouillon contains the least salt. In addition, the research carried out shows that the packaging texture has a strong influence on the salt perception of the consumer. The consumer experiences the content of the rough/granular texture as saltier than the content of the rough texture and the smooth texture. It also appears that the rough texture results in a higher salt perception than the smooth texture. These results can probably be explained by the fact that the rough/granular texture and rough texture remind the respondents of the texture of salt, the rough/granular texture even more than the rough texture. These findings can make a big contribution to the solution of excessive salt intake and the existing initiatives to make consumers aware of the salt content in products (e.g. traffic light system). However, the salt content of the product must be taken into account as it has been found that the effect of the rough/granular texture on salt perception tilts when the minimum salt bouillon is served. Then, the rough/granular texture results in the lowest salt perception and the smooth texture results in the highest salt perception. This is in line with the research of Van Rompay and Groothedde (2019) and can be explained by the expectation disconfirmation theory of Bhattacherjee and Permkumar (2004). The fact is that when the respondents feel the rough/granular texture, they expect a salty content. If the actual content is not at all salty, as is the case with the minimum salt bouillon, the effect tilts, because the actual taste differs too much from the expected taste. So although there is a possibility to enhance the salt perception of the consumer through packaging textures, one has to be careful. This research shows that there must be enough salt in a product to enhance the salt perception. If there is not enough salt in the product, as a result of which the product experience does not meet the product expectations of the consumer, it could lead to long-term negative consequences for the perception and consumption of the product (Bhattacherjee & Permkumar, 2004; Spence, 2012).

Further, the influence of salt levels in bouillon and the packaging textures on the hedonic taste evaluation were examined. It has been found that the different salt levels in bouillon have an influence on the hedonic taste evaluation. This study shows that the higher the salt level in the bouillon, the higher the hedonic taste evaluation of the consumer. This result is in line with the 'health-pleasure trade-off' from Bialkova et al. (2013), which states that unhealthy is experienced as tastier. No significant results were found when investigating the effect of packaging textures on the hedonic taste evaluation. Veryzer (1993) states that the assessment of a product is formed by several factors, in

which visual factors are very important. In this research, the respondents perhaps expected a very attractive serving package or found black a strange color for a serving package to serve bouillon in. This could perhaps be the reason that the influence of packaging textures on hedonic taste evaluation could not be proven in this study. It may also be due to a possible lack of congruence in the eyes of the respondents. Research by Piqueras-Fiszman and Spence (2012) shows that the evaluations of respondents were only influenced by tactile stimuli when the characteristics of the product packaging were congruent with the characteristics of the product. It also appears that when there is congruence between the packaging texture and its content, the product evaluation is rated higher (Van Rompay et al., 2017). In the eyes of the respondents, the characteristics of the used packaging textures may not have been congruent with the characteristics of bouillon. Further, an interaction effect has been found. However, this interaction effect only arises when minimum salt bouillon is served. The smooth texture then results in a higher hedonic taste evaluation than the rough texture and the rough/granular texture. This can be explained by the expectation disconfirmation theory of Bhattacherjee and Permkumar (2004). The rough texture and the rough/granular texture create the expectation that the content will be salty and, because of the health-pleasure trade-off (Bialkova et al., 2013), tasty. When the minimum salt bouillon is served in combination with these textures, the expected taste and the real taste are too far apart, which tilts the effect of the textures. This shows that the amount of salt in a product also plays a role in the hedonic taste evaluation and should be taken into consideration.

In addition, the influence of salt levels in bouillon and the packaging textures on the health perception was examined. It appears that only the different salt levels in bouillon have an effect on health perception. It appears that the higher the salt level in the bouillon contains, the lower the health perception is. This is in line with the expectations and also not a surprising outcome, because it is generally known that (too much) salt is unhealthy. The product packaging does not appear to affect health perception. This result is in line with the results of the study by Van Rompay and Groothedde (2019). The reason for this could be that bouillon is not considered to be as healthy as expected prior to this study. Consumers possibly experience bouillon as fat and/or salt, which results in a low health perception, regardless of the packaging. So, the health perception of products that are experienced as unhealthy cannot be influenced by packaging textures. Whether the packaging textures can influence products that are perceived as healthy could be determined by follow-up research.

Research has also been done into the influence of salt levels in bouillon and packaging textures on the purchase intention. First of all, it turned out that the different salt levels in bouillon influence the purchase intention. The higher the salt level in the bouillon, the higher the purchase intention. This is not a surprising result, since bouillon with a higher salt level is also experienced as tastier, as described earlier. There also appears to be an effect between the packaging textures and the purchase intention. The smooth texture results in a lower purchase intention than both the rough texture and the rough/granular texture when medium salt bouillon or maximum salt bouillon are served. This first of all shows that the amount of salt in a product is very important for influencing the

purchase intention of the consumer. In addition, Veryzer (1993) states that the assessment of a product is formed by several factors. In this study, the rough texture and rough/granular texture are more fun and exciting to see and feel than the smooth texture, resulting in a higher purchase intention for the rough texture and the rough/granular texture. These results can also contribute to tackling the problem of excessive salt intake. The product packaging of products with less salt content can be made more appealing to consumers by means of textures. This could make people more inclined to buy those products.

No surprising or striking results were found in the study into the influence of salt levels in bouillon and packaging textures on the psychological effects of consumption and taste intensity.

6.2. Implications

6.2.1. Theoretical implications

The research conducted resulted in interesting insights into the use of textures to influence the salt perception, hedonic taste evaluation and health perception of the consumer. This study adds value to the existing theoretical knowledge, due to limited research in the field of tactile stimuli and its influence on the total product evaluation of the consumer. Although this research is based on an earlier study by Van Rompay and Groothedde (2019), new insights have been gained that have not been revealed before. First of all, a clearer association has been found between textures and salt perception. Van Rompay and Groothedde (2019) showed that a package with a rough, granular texture results in a higher salt perception, which means that less salt needs to be added to the products to experience the same salt perception. However, in their study it was not yet clear which design aspects were primarily responsible for the heightened saltiness perception. In this study, it has been found that both the rough texture and the rough/granular texture enhance the salt perception. However, the rough/granular texture boosts salt perception more than the rough texture. Moreover, the research was conducted with a relatively healthy product, in contrast to the research by Van Rompay and Groothedde (2019), where they used chips. And although the bouillon was not considered to be very healthy, it was experienced as healthier than the chips was in the research by Van Rompay and Groothedde (2019). Therefore, this study shows that the rough texture and the rough/granular texture can increase salt perception for both unhealthy products and healthier products. Furthermore, a serving package was used in this study, while in other studies a product package is often used. This demonstrates that a serving package can also influence the consumer's perception. Finally, this study demonstrated that the health perception of products that are experienced as unhealthy cannot be influenced by packaging textures. This study has initiated further research into the influence of tactile stimuli on salt perception. Follow-up research will lead to more specific results and possibly multiple effects. Recommendations for future research are given later in this chapter.

6.2.2. Practical implications

The excessive consumption of salt is a major problem nowadays. Although many promising results have emerged from this study, careful consideration about practical implications is necessary. A good place to apply the results could be a hospital. It is important that the people staying there eat healthy in order to recover as quickly as possible and to feel better. For people who only eat liquid food, the bowls/glasses from which people drink could be provided with a rough/granular texture. Another possibility could be providing a straw with the rough/granular texture. By adding this texture, the salt perception increases, so that the food can be prepared with less salt. For the people who eat solid food and therefore eat with cutlery, the handles of the cutlery could be provided with the rough/granular texture. The disadvantage with the cutlery is that a lot of food is eaten with it, including food that should not be salty, such as red cabbage. This could cause the patients to find the food less tasty, which makes them eat less, which does not benefit their recovery. If the idea does turn out well in hospitals, it might also lead to disadvantages as soon as the patient returns home. When the former patient cooks at home and eats with smooth feeling cutlery, there is a chance that they will add more salt, because the food tastes more bland than it did in the hospital. In short, more research is needed for the implication of this idea.

When looking at more generic implications, the rough/granular texture can also be used by different food distributors. For example, the packaging in the supermarket can be adjusted, so that salt perception is increased and less salt can be used in the products. This research has shown that adjusting the texture does not only influence that salt perception. By making the packaging rough/granular, the hedonic taste evaluation and the purchase intention might also increase. In addition to the health benefits of the consumer, the distributors also experience benefits. For example, less salt is needed for the products and, in addition, the products are rated higher on taste and the purchase intention of the consumer is growing. In addition, snack bars can, for example, make use of serving trays with the rough/granular texture. The fries or snack that is served in the tray then requires less salt to bring about the same salt perception. Although the consumer will probably still eat unhealthy food, it will certainly consume less salt. Another example is the cinema. The salty popcorn can be offered in a rough/granular package, so that less salt has to be used for the popcorn. So, the results of this study can be used to make consumers eat healthier, without them being aware of it. The distributors are very important here, they must be persuaded that the replacement of the packages is worth it.

What is very important for each implication is that there is still enough salt in the product, otherwise the effect will tilt. In this study, the rough/granular texture still worked when the bouillon contained slightly more than half of the original amount of salt.

6.3. Limitations and recommendations for future research

Like all research, this study has some limitations. In this study 3D printed cups were used, these cups are exactly the same in size, color and material, but the strength of the cups differs a bit from each other. The rough/granular cup is, because of the layer with grains, stronger than the smooth cup and the rough cup, this means that the smooth cups and the rough cup are somewhat more flexible than the rough/granular cup. For future research, it is desirable to make all materials of the same strength and flexibility, this can be done by slightly modifying the design of the cups. The smooth cup and rough cup can be made thicker, so that they also get a stronger feel. Another possibility may be to use harder materials, such as glass or porcelain.

Furthermore, the results show that bouillon is not really considered to be as healthy as was expected prior to the study. People possibly experience bouillon as fat and/or salt, which means that the health perception is low. For future research it can therefore be interesting to do research on products that consumers experience as healthy, such as soybeans or nuts.

In addition, the packaging was visible to the participants, which means that the visual aspects of the packaging may have influenced the results with regard to the general product evaluation (Veryzer, 1993). This could also explain why, in this study, the different packaging textures do not have a clear effect on the hedonic taste evaluation. Veryzer (1993) states that the assessment of a product is formed by several factors, in which visual factors are very important. In this research, the respondents perhaps expected a very attractive serving package or found black a strange color for a serving package to serve bouillon in. For follow-up research it could be an interesting possibility to let the respondents participate blindfolded, this way the tactile stimuli will only be experienced through physical contact.

Moreover, this research has shown that tactile stimuli can influence the salt perception of the consumer and although several studies have already focused on different tastes in combination with sensory stimuli, research into the influence of tactile stimuli remains limited. It is interesting to conduct further research into salt perception, but the sour and umami taste perception have also not been sufficiently investigated. New cross-modal correspondences can be used in the future to make people eat healthier and to advertise products in a more appropriate way.

It can also be interesting for follow-up research to print the textures used in this research on a product packaging, this is the packaging of a product when it is offered for sale (e.g. in a store). In this study, use was made of serving packaging that has a hard feel. Future research can show whether these textures can also be used on soft packaging (such as a noodle or chips packaging) and whether they also result in the same outcomes.

Another interesting research topic is the psychology behind the effects. For example, it could be investigated whether the rough/granular texture results in the same effects if the participants know in advance that this texture should result in a higher salt perception. There could be a self-fulfilling prophecy, whereby the textures result in the same effects, or perhaps even stronger effects. In addition,

it could also be that the effect is tilted, because people are aware of the effect and do not want to be 'fooled'. Research could also be done into the 'sustainability' of the effect, could people get used to the texture and its effect? This is certainly interesting if the textures are implemented in homes or hospitals, where people come into contact with the textures every day. It could be interesting to investigate whether the effect disappears after a while.

The recommendations above suggest that the current study can be used as a basis for future research. There are many possibilities to increase the existing knowledge about the influence of tactile stimuli on the product perception of the consumer.

Literature

Ares, G., & Deliza, R. (2010). Studying the influence of package shape and colour on consumer expectations of milk desserts using word association and conjoint analysis. *Food Quality and Preference, 21*, 930-937. doi:10.1016/j.foodqual.2010.03.006

Barnett-Cowan, M. (2010). An illusion you can sink your teeth into: Haptic cues modulate the perceived freshness and crispness of pretzels. *Perception, 39*(12), 1684–1686. doi:10.1068/p6784

Becker, L., van Rompay, T. J. L., Schifferstein, H. N. J., & Galetzka, M. (2011). Tough package, strong taste: The influence of packaging design on taste impressions and product evaluations. *Journal of Food Quality and Preference, 22*, 17-23. doi:10.1016/j.foodqual.2010.06.007

Bhattacherjee, A., & Premkumar, G. (2004). Understanding changes in belief and attitude toward information technology usage: A theoretical model and longitudinal test. *MIS Quarterly, 28*(2), 229-254.

Bialkova, S., Grunert, K. G., & Van Trijp, H. (2013). Standing out in the crowd: the effect of information clutter on consumer attention for front-of-pack nutrition labels. *Food Policy, 41*, 65-74. doi:10.1016/j.foodpol.2013.04.010

Jo, J. & Jayson, L. L. (2018). If it's healthy, it's tasty and expensive: Effects of nutritional labels on price and taste expectations. *Food Quality and Preference, 68*, 332-341. doi:10.1016/j.foodqual.2018.04.002

Kloss, L., Meyer, J. D., Graeve, L., & Vetter, W. (2015). Sodium intake and its reduction by food reformulation in the European Union - A review. *NFS Journal, 1*, 9-19. doi:10.1016/j.nfs.2015.03.001

Knöferle, K., & Spence, C. (2012). Crossmodal correspondences between sounds and tastes. *Psychonomic Bulletin & Review, 1*, 1-15. doi:10.3758/s13423-012-0321-z

Krishna, A., & Morrin, M. (2007). Does touch affect taste? The perceptual transfer of product container haptic cues. *Journal of Consumer Research, 34*(6), 807-818. doi:10.1086/523286

Ngo, M. K., Misra, R., & Spence, C. (2011). Assessing the shapes and speech sounds that people associate with chocolate samples varying in cocoa content. *Food Quality and Preference, 22*(6), 567-572. doi:10.1016/j.foodqual.2011.03.009

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*. Urbana, Il: University of Illinois Press.

Piqueras-Fiszman, B., & Spence, C. (2012). The influence of the feel of product packaging on the perception of the oral-somatosensory texture of food. *Food Quality and Preference, 26*(1), 67-73. doi:10.1016/j.foodqual.2012.04.002

Schifferstein, H. N. J., Fenko, A., Desmet, P. M. A., Labbe, D., & Martin, N. (2013). Influence of package design on the dynamics of multisensory and emotional food experience. *Food Quality and Preference, 27*(1), 18-25. doi:10.1016/j.foodqual.2012.06.003

Schwarz, N., & Bless, H. (1992). Constructing reality and its alternatives: An inclusion/exclusion model of assimilation and contrast effects in social judgement. In L. L. Martin, & A. Tesser (Ed.), *The construction of social judgements* (pp. 217-413). Mahwah, NJ: Lawrence Erlbaum Associates.

Slocombe, B. G., Carmichael, D. A., & Simner, J. (2016). Cross-modal tactile–taste interactions in food evaluations. *Neuropsychologia, 88*, 58-64. doi:10.1016/j.neuropsychologia.2015.07.011

Spence, C. (2012). Managing sensory expectations concerning products and brands: Capitalizing on the potential of sound and shape symbolism. *Journal of Consumer Psychology, 22*(1), 37-54. doi:10.1016/j.jcps.2011.09.004

Spence, C., & Gallace, A. (2011). Multisensory design: Reaching out to touch the consumer. *Psychology & Marketing, 28*(3), 267-308. doi:10.1002/mar.20392

Tu, Y., Yang, Z., & Ma, C. (2015). Touching tastes: The haptic perception transfer of liquid food packaging materials. *Food Quality and Preference, 39*, 124-130. doi:10.1016/j.foodqual.2014.07.001

Van Rompay, T. J. L., Finger, F., Saakes, D., & Fenko, A. (2017). "See me, feel me": Effects of 3D-printed surface patterns on beverage evaluation. *Food Quality and Preference, 62*, 332–339. doi:10.1016/j.foodqual.2016.12.002

Van Rompay, T. J. L., Groothedde, S. (2019). The taste of touch: Enhancing saltiness impressions through surface texture design. *Food Quality and Preference*. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S095032931830541X

Van Rompay, T. J. L., Kramer, L. M., & Saakes, D. (2018). The sweetest punch: Effects of 3D-printed surface textures and graphic design on ice-cream evaluation. *Food Quality and Preference, 68*, 198-204. doi:10.1016/j.foodqual.2018.02.015

Velasco, C., Woods, A. T., Liu, J., & Spence, C. (2016). Assessing the role of taste intensity and hedonics in taste/shape correspondences. *Multisensory Research, 29*(3), 209-221. doi:10.1163/22134808-00002489

Verastegui-Tena, L., Van Trijp, H., & Piqueras-Fiszman, B. (2019). Heart rate, skin conductance, and explicit responses to juice samples with varying levels of expectations (dis)confirmation. *Food Quality and Preference, 71*, 320-331. doi:10.1016/j.foodqual.2018.08.011

Veryzer, R. W. (1993). Aesthetic Response and the Influence of Design Principles on Product Preferences. *Advances in Consumer research, 20*(1), 224–29.

Yeomans, M. R., Chambers, L., Blumenthal, H., & Blake, A. (2008). The role of expectancy in sensory and hedonic evaluation: The case of smoked salmon ice-cream. *Food Quality and Preference, 19*(6), 565-573. doi:10.1016/j.foodqual.2008.02.009

Zhang, Y., Feick, L., & Price, L. J. (2006). The impact of self-construal on aesthetic preference for angular versus rounded shapes. *Personality and Social Psychology Bulletin, 32*(6), 794-805. doi:10.1177/0146167206286626

Appendix

Appendix 1: Questionnaire pre-test 1

Beste deelnemer/deelneemster,

In het kader van de masteropleiding Communication Studies aan de Universiteit Twente doe ik een onderzoek naar de invloed van verpakkingstexturen op de smaakperceptie van de consument. Het onderzoek gaat als volgt in zijn werk: Er worden drie cups, waaruit gedronken kan worden, aan u getoond. Voor elke cup zijn er vervolgens 6 vragen die beantwoord moeten worden. Het is de bedoeling dat u niet te lang nadenkt bij het invullen van de vragen, het gaat om uw eerste indruk. Het invullen van deze vragenlijst zal ongeveer 5 minuten duren. Uw antwoorden worden anoniem verwerkt. U kunt op elk moment, zonder opgaaf van redenen, uw deelname aan dit onderzoek beëindigen.

Alvast hartelijk dank voor uw deelname.

Met vriendelijke groet,

Sara Groothedde

Cup 1

Ik ben een: man/vrouw/zeg ik liever niet

Leeftijd: ……………………………… jaar

Bekijk de cup goed en beantwoord de vragen.

1. Ik ervaar de textuur van deze cup als:

Ruw	☐	☐	☐	☐	☐	Glad
Korrelig	☐	☐	☐	☐	☐	Vlak
Hard	☐	☐	☐	☐	☐	Zacht
Prikkelend	☐	☐	☐	☐	☐	Egaal

Geef bij de volgende stellingen aan in hoeverre u het ermee eens bent:

2. Deze cup is geschikt om uit te drinken

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

3. Deze cup voelt prettig aan

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

4. Deze cup is realistisch om uit te drinken

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

5. Deze cup past bij het producttype

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

6. Wat kan er aan deze cup veranderd worden zodat deze nog geschikter is om uit te drinken?

_____
_____
_____
_____

Cup 2

Ik ben een: man/vrouw/zeg ik liever niet

Leeftijd: ………………………………… jaar

Bekijk de cup goed en beantwoord de vragen.

1. Ik ervaar de textuur van deze cup als:

Ruw	☐	☐	☐	☐	☐	Glad
Korrelig	☐	☐	☐	☐	☐	Vlak
Hard	☐	☐	☐	☐	☐	Zacht
Prikkelend	☐	☐	☐	☐	☐	Egaal

Geef bij de volgende stellingen aan in hoeverre u het ermee eens bent:

2. Deze cup is geschikt om uit te drinken

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

3. Deze cup voelt prettig aan

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

4. Deze cup is realistisch om uit te drinken

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

5. Deze cup past bij het producttype

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

6. Wat kan er aan deze cup veranderd worden zodat deze nog geschikter is om uit te drinken?

_____
_____
_____
_____

Cup 3

Ik ben een: man/vrouw/zeg ik liever niet

Leeftijd: ………………………………… jaar

Bekijk de cup goed en beantwoord de vragen.

1. Ik ervaar de textuur van deze cup als:

Ruw	☐	☐	☐	☐	☐	Glad
Korrelig	☐	☐	☐	☐	☐	Vlak
Hard	☐	☐	☐	☐	☐	Zacht
Prikkelend	☐	☐	☐	☐	☐	Egaal

Geef bij de volgende stellingen aan in hoeverre u het ermee eens bent:

2. Deze cup is geschikt om uit te drinken

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

3. Deze cup voelt prettig aan

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

4. Deze cup is realistisch om uit te drinken

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

5. Deze cup past bij het producttype

Helemaal niet mee eens	☐	☐	☐	☐	☐	Helemaal mee eens

6. Wat kan er aan deze cup veranderd worden zodat deze nog geschikter is om uit te drinken?

_____
_____
_____
_____

Appendix 2: Questionnaire pre-test 2

Beste deelnemer/deelneemster,

In het kader van de masteropleiding Communication Studies aan de Universiteit Twente, doe ik onderzoek naar de invloed van verpakkingstexturen op de smaakperceptie van de consument. Het onderzoek gaat als volgt in zijn werk: Voor u staan 5 kommetjes met daarin wat bouillon. Uit elke kom proeft u wat bouillon, voor elke bouillon zijn er vervolgens twee vragen die beantwoord moeten worden. Het is de bedoeling dat u niet te lang nadenkt bij het invullen van de vragen, het gaat om uw eerste indruk. Het invullen van deze vragenlijst zal ongeveer 5 minuten duren. Uw antwoorden worden anoniem verwerkt. U kunt op elk moment, zonder opgaaf van redenen, uw deelname aan dit onderzoek beëindigen.

Alvast hartelijk dank voor uw deelname.

Met vriendelijke groet,

Sara Groothedde

Bouillon 1
Dit product smaakt zout

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Ik vind dit product lekker

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Ik zou dit product kopen in de winkel

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Bouillon 2
Dit product smaakt zout

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Ik vind dit product lekker

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Ik zou dit product kopen in de winkel

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Bouillon 3
Dit product smaakt zout

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Ik vind dit product lekker

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Ik zou dit product kopen in de winkel

Helemaal niet
mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal
mee eens

Bouillon 4

Dit product smaakt zout

Helemaal niet
mee eens
□ □ □ □ □ □ □
Helemaal
mee eens

Ik vind dit product lekker

Helemaal niet
mee eens
□ □ □ □ □ □ □
Helemaal
mee eens

Ik zou dit product kopen in de winkel

Helemaal niet
mee eens
□ □ □ □ □ □ □
Helemaal
mee eens

Bouillon 5

Dit product smaakt zout

Helemaal niet
mee eens
□ □ □ □ □ □ □
Helemaal
mee eens

Ik vind dit product lekker

Helemaal niet
mee eens
□ □ □ □ □ □ □
Helemaal
mee eens

Ik zou dit product kopen in de winkel

Helemaal niet
mee eens
□ □ □ □ □ □ □
Helemaal
mee eens

Appendix 3: Questionnaire main study

Beste deelnemer/deelneemster,

In het kader van de masteropleiding Communication Studies aan de Universiteit Twente doe ik onderzoek naar een nieuw merk bouillon. Het onderzoek gaat als volgt in zijn werk: Voor u staat een cup met daarin de bouillon. U pakt de cup vast en drinkt daaruit de bouillon. Vervolgens vult u de bijbehorende vragenlijst in. Het is de bedoeling dat u niet te lang nadenkt bij het invullen van de vragen, het gaat om uw eerste indruk. Het invullen van deze vragenlijst zal ongeveer 10 minuten duren. Uw antwoorden worden anoniem verwerkt. U kunt op elk moment, zonder opgaaf van redenen, uw deelname aan dit onderzoek beëindigen.

Alvast hartelijk dank voor uw deelname.

Met vriendelijke groet,

Sara Groothedde

Ik ben een
☐ Man   ☐ Vrouw

Mijn leeftijd is: ……. jaar

Dit product smaakt zout
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

Deze bouillon smaakt intens
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

Deze bouillon smaakt hartig
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

Deze bouillon smaakt krachtig
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

Dit product is lekker
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

De smaak van dit product bevalt me
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

De smaak van dit product is hoe ik vind dat hij moet zijn
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

De smaak van dit product spreekt me aan
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

Ik denk dat dit product veel calorieën bevat
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

Ik verwacht dat dit product veel vet bevat
Helemaal niet   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Helemaal
mee eens   mee eens

Dit product smaakt gezond

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

Ik verwacht dat dit product natuurlijk is

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

Ik ben verrast door de smaak van de bouillon

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

Dit is de smaak die ik verwacht bij een bouillon

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

In welke mate kikkert u op na het drinken van deze bouillon

Helemaal niet ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal wel

In welke mate krijgt u energie van deze bouillon

Helemaal niet ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal wel

In welke mate voelt u dat u er weer even tegenaan kan, na het drinken van deze bouillon

Helemaal niet ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal wel

In welke mate knapt u op na het drinken van deze bouillon

Helemaal niet ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal wel

Wanneer ik in de supermarkt ben om bouillon te kopen, zou ik deze bouillon overwegen

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

Als deze bouillon in de supermarkt ligt, zou ik deze bouillon willen uitproberen

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal mee eens

Nu ik deze bouillon geproefd heb, ben ik nieuwsgierig naar deze bouillon

Helemaal niet mee eens ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helemaal mee eens