THE USE OF FACE READING TECHNOLOGY TO PREDICT CONSUMER ACCEPTANCE OF CONFECTIONERY PRODUCTS

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Abstract

Traditional sensory and consumer tests predict consumer acceptance of new products rather poorly, as evidenced by the high their failure rates in the market. These tests typical reflect conscious processes whereas consumer acceptance may also be based on unconscious processes.

The aims of this work were to examine whether facial expressions measured with the Noldus FaceReader technology can be used for differentiating between differing sugar confectionery products (various types of sweets and chocolates), and to investigate whether facial reactions are able to explain liking ratings on hedonic scales.

Naive consumers (mean age 22 years) were recruited at the Kaunas University of Technology. They were asked to rate the sample with an intentional facial expression, which was recorded and then characterized by FaceReader program (Noldus Information Technology, Wageningen, The Netherlands). The measurements showed significant differences between facial expressions elicited by the different samples of tested sugar confectionery products and reflected the introspective liking ratings well. The positive correlations of facial expression "happy", and negative correlations of "sad" expression intensity against self-reported liking ratings suggest that these may be the most valuable descriptors for explaining the self-reported hedonic quality of sweets and chocolates. It can be concluded that Noldus FaceReader technology is sufficiently accurate for differentiating between sugar confectionery products and can deliver additional information to conventional acceptance tests.

***Keywords*:** sugar confectionery products, consumers, facial expressions, hedonic liking, FaceReader.

Introduction

Up to 80% of all new food products fail in the marketplace, despite the fact that they are typically subjected to a large number of sensory and consumer tests before their market introduction. This suggests that the standard sensory and consumer tests, which typically include sensory analytical profiling and liking tests, have a low predictive validity with respect to general product performance. Possibly, consumer food choice outside the laboratory may be less based on cognitive information processing and rational reasoning, and more on unarticulated / unconscious motives and associations (Dijksterhuis, Smith, 2005; Köster, 2009). Reasons for likes or dislikes of different foods are typically difficult to articulate but may determine much of our food choice. Certain foods are more attractive than other foods because for some reason they make us feel good – i.e. they trigger positive emotions.

For some time, sensory analysts within the commercial sector have looked for better means to connect with marketing. The measurement of emotions might help in the further connection of sensory science and marketing. The measurement of emotions also serves as a further tool to support product development. Measurement of emotions allows us to compare existing products, and measure the emotional response to product prototypes. In these ways, the measurement of emotions can provide a common lexicon for sensory and marketing to communicate and for product development that meet a marketing need. Emotions can be the common language to bring these areas together.

There are many studies showing that tastes and odours elicit different emotions and facial reactions in neonates (Soussignan et al., 1997) children (Soussignan, 1996; Zeinstra et al., 2009) and adults (Greimel et al., 2006; Wendin et al., 2011). In most of these studies quite intense stimuli were used, like for example, concentrated basic taste solutions (Wendin et al., 2011) or odours ranging from fruity to fecal (Soussignan, 1996). The study of emotions in relation to food choice has recently advanced by work of King and Meiselman (2010) and De Smet and Schiffertein (2008). Their results suggest that most emotions related to food are mildly positive, are only partly related to liking, and improve the predictions of food choice.

Facial expressions can be analyzed with the anatomically based Facial Action Coding System (FACS). These FACS analyses are very time-consuming and require trained observers. To overcome these difficulties, different automated facial expression recognition systems like Nviso (Nviso SA, Lausanne, Switzerland), Affdex (Affectiva Inc., Waltham, USA) and FaceReader (Noldus Information Technology, Wageningen, The Netherlands) have been developed. These systems are capable of analyzing facial expression patterns from video data. Currently, these systems are used mainly for research in the fields of psychology, education, market research and consumer behaviour. De Wijk et al. (2012) analyzed the facial expressions elicited by the prospect of tasting or smelling liked or disliked food with FaceReader. The first sight of disliked foods compared to liked foods resulted in increased facial expressions of sadness, disgust, and angriness. However up until now, little work has been published about the measurement of facial expressions elicited directly by the actual tasting of food products using facial expression recognition

technology. Danner et al. (2014) examined consumers' facial reactions elicited by the flavour of orange juice products using FaceReader technology in implicit and an explicit measurement approach. Both, implicit and explicit measurements showed significant differences between facial expressions elicited by the different samples. The explicit measurement reflected the introspective liking ratings well. Especially expressions happy and disgusted showed a high correlation with liking and were good indicators for liked and disliked samples, respectively. To minimize artefacts, caused by eating and drinking, which can be easily misinterpreted by the FaceReader software as emotion, they used liquid samples (juice) which need less processing in the mouth than solid samples.

The aim of this work was to examine whether facial expressions measured with the Noldus FaceReader technology are a sufficiently accurate measure for differentiating between various types of sugar confectionery products (sweets and chocolates), and to investigate whether facial reactions are able to explain such product liking ratings on hedonic scales.

Materials and Methods

Samples and sample preparation

Six different types of sugar confectionery products were tested in the experiment. Each set of tested products was made from 3 to 4 samples with significant differences in flavour or texture (Table 1). All samples were presented in a sequential way, at room temperature (20–22 °C), randomized and coded. Water was provided to rinse the mouth before and between tasting the samples. All tested sugar confectionery products were commercial products delivered by various Lithuanian companies.

Table 1

Samples of sugar confectionery products

Products	Significant difference
Chocolate bars	Different additives: peanuts, hazelnuts, almonds, coffee
Milk chocolate	Different brand names: Milka, Sonata, Pergale
Sweets "Ruta"	Different fillings: almond, hazelnuts, actinidia, granadilla and white chocolate
Sweets "Ruta" with nutty filling	Different coatings: dark (70% or 50% cocoa solids), white, milk chocolate
Sweets "Ruta" with almond filling	Different coatings: dark (70% or 50% cocoa solids), white, milk chocolate
Caramel "Tropic"	-

Participants and measurements

The number of participants in the testing of each type of sugar confectionery products varied from 12 to 20. All participants were students of the Department of Food Technology, Kaunas University of Technology, with an average age of 22 years.

The experiments took place in the Sensory Laboratory at Kaunas University of Technology. At first, participants were introduced to the procedure for tasting. They were asked to taste the whole presented food sample (10 g) at once, take some seconds to think about an impression of it, then give a signal with their right hand and visualize the taste experience of the sample with a facial expression best representing their liking of the sample (explicit measurement). Afterwards, they rated their liking or disliking of the sample on a 7-point hedonic scale, ranging from 1 (dislike extremely) to 7 (like extremely).

The whole procedure was filmed with a Microsoft LifeCam Studio webcam, mounted on the laptop facing the participants, using Media Recorder software (Noldus Information Technology, Wageningen, The Netherlands). The recordings with a resolution of 640×480 at 25 frames per second were saved as AVI files and analyzed frame by frame with FaceReader 5 software (Noldus Information Technology, Wageningen, The Netherlands), scaling the 6 basic emotion patterns (angry, happy, disgusted, sad, scared, surprised) and neutral from 0 (not present at all) to 1 (maximum intensity of the fitted model). For each sample, the section of intentional facial expression (exactly from the point when the subject had finished raising their hand to give the signal until the subject started lowering the hand again) was extracted and used for the statistical analysis. FaceReader contains an image quality bar, which gives a good indication of how well the program is able to model the face depicted in the image. For the best image quality, the main attention was focused on camera position and illumination. For this reason, participants were asked to sit and look frontally into the camera. All of the participants agreed to the use of their data in the context of this experiment.

Statistical analysis

For the statistical analysis, the maximum values of the facial expression patterns (angry, disgusted, happy, sad, scared, surprised, and neutral) of the respective section were used. To examine the correlation between facial expressions and the hedonic liking, a Multiple Linear Regression was performed. All analyses were performed with STATISTICA V10 (StatSoft, Inc., Tulsa, OK, USA). Significance of differences between treated samples was evaluated by using Duncan's multiple range tests at a 5 percent level ($p<0.05$).

Results and Discussion

Results of experiments showed that there were significant differences in facial expressions between tasted types of sugar confectionery product (Fig. 1) as well as between the samples of the same type of products (Fig. 2). Tested types of confectionery products differed significantly concerning the emotion patterns happy, sad and angry. The similar tendencies were found during the analysis of the same type of

confectionery products (sweets). The sweets also were differ in emotion pattern surprised. No significant differences ($p>0.05$) in other facial expressions between tested samples were observed.

It was noticed, that the caramel samples elicited significantly more intense facial reactions of happy than all other tested confectionery products. Sweets "Ruta", especially with dark chocolate (70 % cocoa) elicited the strongest sad facial expressions, significantly differing from all others. The statistical analyses of the self-reported liking ratings identified the caramel "Tropic" as the most liked sample and the chocolate bars as the least liked. The data collected suggest that emotional intensity sometimes tracks with acceptance, and sometimes differs. For example, the acceptances of sweet with different fillings do not track with the emotion profile (Fig. 2). Thus emotions might help to explain acceptance data and why acceptance data might not always predict market success.

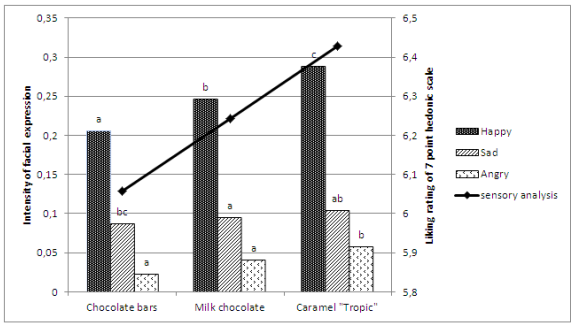

Figure 1. Intensity of facial expressions and self-reported liking of different types of sugar confectionary

While the measurement of emotions gives new information beyond acceptance, it is nevertheless interesting to relate emotions and acceptance. Linear regressions of the mean values of the facial expressions showed positive correlations of happy and negative correlations of sad (Table 2). This indicates that liked samples elicited more intense facial expressions of happy than disliked samples.

This study shows that measuring facial expressions using Noldus FaceReader 5 is a sufficiently accurate method to differentiate between various sugar confectionery samples. Discrimination between liked and disliked samples was possible on the basis of the intensity of elicited happy and sad facial expressions. This supports the findings of Danner et al. (2014) who used the FaceReader technology for study of orange juice and found high correlation of facial reactions happy and disgusted with liking.

It should also be mentioned that some differences in the intensity of facial reactions between participants were observed. The participants could be divided into two groups, the ones who showed clearly visible facial reactions when tasting the samples and those who had a poker face showing only little to almost no facial reactions. This can partially be attributed to the sensory laboratory test setup, where the participants are facing an unfamiliar environment and may feel stressed to a certain degree, or are very concentrated on the task.

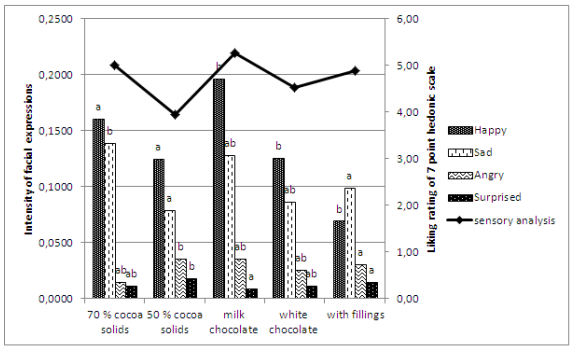

Figure 2. Intensity of facial expressions and self-reported liking of sweets "Ruta" with different coatings

DC1 – dark chocolate coating (70% cocoa solids),
DC2 – dark chocolate coating (50% cocoa solids),
MC – milk chocolate coating, WC – white chocolate coating

Table 2

Correlation of facial expression intensity against self-reported liking of different sugar confectionary products

Products	Emotions				
	N	H	Sa	A	Su
Chocolate bars	-0.39	0.14	-0.70	-0.98	-0.15
Caramel "Tropic"	-0.24	0.68	-0.03	-0.82	-0.54
Milk chocolate	0.72	0.33	-0.49	1.00	0.48
"Ruta"[1]	0.62	0.73	-0.60	0.31	0.50
"Ruta"[2]	-0.85	0.52	-0.36	-0.48	-0.32
"Ruta"[3]	-0.84	0.87	-0.23	-0.96	-0.69

N – neutral; H – happy; Sa – sad; A – angry; Su – surprised; Sc – scared; D –disgusted; [1] – with different fillings; [2] – with nutty filling and different coatings; [3] – with almond filling and different coatings

Further examinations in a more natural environment, also if possible without directly asking the participants to rate the products, could be interesting.

It is also important to point out the limitations and requirements of FaceReader technology. It does not work with children below the age of three. Pose, movement and rotation of the test person are limited. The test person needs to face the camera head on (angle <40°). The face must not be partially obscured by hair or when handling samples.

Motor artefacts, caused by eating and drinking, can be misinterpreted by the FaceReader software as emotion. In more complex tasting situations, like full meals that involve longer and potentially overlapping oral processing actions, motor artefacts can compromise the measurement of facial expressions to a higher degree.

Conclusions

It could be concluded that NoldusFaceReader technology is sufficiently accurate to detect significant differences in facial expressions elicited by different

samples of sugar confectionery products, such as chocolates, sweets, caramel, and can deliver additional information to conventional acceptance tests. However, more research is needed to see how this technology performs in more complex testing procedures, simulated or real life environments.

The positive correlations of happy and negative correlations of sad expression intensity against self-reported liking ratings suggest that these may be the most valuable descriptors for explaining the self-reported hedonic quality of sugar confectionery products.

Acknowledgment

The research was funded by a grant (EUREKA ITEA 2 project 11005 Empathic) from Lithuanian Agency for Science, Innovation and Technology.

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