Food Quality and Preference 32 (2014) 167–172

Contents lists available at SciVerse ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Make a face! Implicit and explicit measurement of facial expressions elicited by orange juices using face reading technology

Lukas Danner *, Liudmila Sidorkina, Max Joechl, Klaus Duerrschmid

Department of Food Sciences and Technology, University of Natural Resources and Life Sciences, Muthgasse 18, A-1190 Vienna, Austria

ARTICLE INFO

Article history:
Received 29 October 2012
Received in revised form 14 January 2013
Accepted 14 January 2013
Available online 23 January 2013

Keywords:
Facial expressions
FaceReader
Hedonic liking
Implicit measurement

ABSTRACT

This study examined consumers' facial reactions elicited by the flavor of orange juice products using an implicit and an explicit measurement approach. The aims of this work were (a) to examine whether facial expressions measured with the Noldus FaceReader technology are a sufficiently accurate measure for differentiating between more or less differing orange juice samples, (b) to elucidate the relation between implicit and explicit facial reactions elicited by orange juices, and (c) to investigate whether implicit and/or explicit facial reactions were able to explain introspective liking ratings on hedonic scales.

Different orange juices, including diluted syrup, nectar, 100% juices and not-from-concentrate (NFC) juice, were used as samples. Naive consumers were recruited at the University. In the implicit approach, the volunteers were not informed that they were video-recorded and their unintentional, automatic facial reactions during and after tasting the different samples were analyzed with Face Reader 4 (Noldus Information Technology, Wageningen, The Netherlands). FaceReader 4 distinguishes between seven facial reaction patterns, representing six basic emotions (angry, happy, disgusted, sad, scared, surprised) and neutral. In the explicit measurement experiment, subjects were asked to rate the sample with an intentional facial expression, which was recorded and then characterized by FaceReader as well.

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 "happy" and "disgusted" showed a high correlation with liking and were good indicators for liked and disliked samples, respectively. In the implicit measurement experiment, on the other hand, "happy" was no discriminator; instead "neutral", "angry" and "disgusted" explained the introspective liking rating well. However the discrimination between samples was better in the explicit than in the implicit condition.

1. Introduction

The flop rate of new food products is high, in spite of extensive sensory and consumer testing conducted before market introduction. This indicates that the used traditional tests are not able to sufficiently predict market performance and that the long-term consumer acceptance for the food products is not adequately reflected by these methods (Köster, 2009; Köster & Mojet, 2007; Rozin, 2007). Most of these test techniques are based on self-reports and therefore underlie a conscious/rational decision making process. There exists growing evidence that consumer choices in real life are mostly driven by unconscious mechanisms rather than conscious and rational ones (Dijksterhuis & Smith, 2005; Köster, 2009). If consumers do not even know why they are deciding the way they decide, how could they give accurate answers about the motives for their behavior? Such considerations explain why the use of implicit measures is regarded as beneficial by an increasing number of sensory and consumer scientists. De Houwer and Moors (2007) defined an implicit measure as "a measurement outcome that reflects the to-be-measured construct by virtue of processes that have the features of automatic processes. Automatic processes on the other hand, have been characterized as unconscious, unintentional, uncontrollable, effortless and fast". There are many studies showing that tastes and odors elicit different facial reactions in neonates (Rosenstein & Oster, 1988; Soussignan, Schaal, Marlier, & Jiang, 1997; Steiner, 1974), children (Soussignan, 1996; Zeinstra, Koelen, Colindres, Kok, & De Graaf, 2009) and adults (Greimel, Macht, Krumhuber, & Ellgring, 2006; Hu et al., 1999; Wendin, Allesen-Holm, & Bredie, 2011). In most of these studies quite intense stimuli were used, like for example, concentrated basic taste solutions (Wendin et al., 2011) or odors ranging from fruity to fecal (Soussignan, 1996). Emotions and the corresponding facial expressions are very brief, in the order of a few seconds (Ekman, 1992).

Facial expressions can be analyzed with the anatomically based Facial Action Coding System (FACS) (Ekman & Friesen, 1977). These FACS analyses are very time-consuming and require trained

* Corresponding author. Tel.: +43 664 2266007.
E-mail address: Lukas.danner@gmail.com (L. Danner).

0950-3293/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.foodqual.2013.01.004

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 online and/or offline. Another approach is facial electromyography, which can detect subtle changes in muscular activities of the face which are unlikely to be recognized with observational techniques (Hu et al., 1999). However due to the application of electrodes on the face, electromyography cannot be regarded as an implicit technique.

For this study we used Noldus FaceReader 4 (Noldus Information Technology, Wageningen, The Netherlands). This software reconstructs the face three-dimensionally, based on 491 model points, allowing a robust and reliable measurement of seven facial reaction patterns, representing six basic emotion patterns (“angry”, “happy”, “disgusted”, “sad”, “scared”, “surprised”) and “neutral”. Robustness and reliability were tested in different studies, including studies by Den Uyl and Van Kuilenburg (2005) and Terzis, Moridis, and Economides (2010), showing that FaceReader agrees with the judgments of trained observers in up to 89% of all cases. Currently, FaceReader is used mainly for research in the fields of psychology, education, market research and consumer behavior.

De Wijk, Kooijman, Verhoeven, Holthuysen, and De Graaf (2012) analyzed the facial expressions elicited by the prospect of tasting or smelling liked or disliked food with FaceReader. 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 FaceReader technology.

In summary, the aims of this work were (a) to test whether facial reactions measured with FaceRader 4 are a sufficiently accurate measure for differentiating between more or less differing orange juice samples, (b) to elucidate the relation between implicit and explicit facial reactions elicited by the juices, and (c) to investigate to which degree implicit and/or explicit facial reactions were able to explain introspective liking ratings on hedonic scales.

2. Material and methods

2.1. Samples and sample preparation

Six different orange juices available on the Austrian market (Table 1), including diluted syrup, nectar, 100% juices and NFC juice, were used as test stimuli in both experimental approaches. All samples were presented in a sequential monadic way, at room temperature (22 °C), randomized and coded. Water was provided to rinse the mouth before and between tasting the samples. The sample syrup was prepared following the manufacturer’s guidelines. One part syrup was diluted with six parts deionised water.

2.2. Experiment 1: explicit measurement of facial expression

2.2.1. Participants and measurements

Seventy-five individuals participated, most of them students, with an average age of 23 years (standard deviation SD = 3.0 years), 52% of which were female. They were familiar with orange juices but the aim of our tests remained concealed to them until the end of the testing procedure. The experiments took place in the sensory lab at the University of Natural Resources and Life Sciences, Vienna. The participants were asked to taste the whole presented sample (30 ml) at once, take twenty seconds to reflect on the taste impressions, 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. No timer was used to allow natural facial expressions and keep the experiment as unobtrusive as possible. Afterwards, they rated their liking or disliking of the sample on a 9-point hedonic scale, ranging from 1 (like extremely) to 9 (dislike extremely). The questionnaire was presented on Laptops using Compusense five (Compusense Inc., Guelph, Canada) software.

Table 1
Orange juice samples.

Code	Producer	Description
Juice 1	Producer A	100% juice
Juice 2	Producer B	100% juice “mild”
Juice 3	Producer C	100% juice
NFC	Producer D	100% NFC Juice
Nectar	Producer B	50% nectar
Syrup	Producer E	10% juice, syrup diluted 1 + 6

The whole procedure was filmed with a Logitech C600 webcam, mounted on the laptop facing the participants, using Media Recorder (Noldus Information Technology, Wageningen, The Netherlands) software. Special care was taken to ensure good illumination of the participant’s face, which is an important requirement for FaceRader 4 (Noldus Information Technology, Wageningen, The Netherlands) to produce reliable results. Also important is that participants are looking directly towards the camera while showing their facial expression. Although the software can handle rotations up to 40°, minimal rotation is desired to ensure optimal quality readings. 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 4 software, scaling the 6 basic emotions and neutral from 0 (not present at all) to 1 (maximum intensity of the fitted model). The software feature “individual calibration” was used for standardization. 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 with Observer XT 10.5 (Noldus Information Technology, Wageningen, The Netherlands) software. Facial expression states for these sections were exported and used for the statistical analysis.

After the experiment, participants were asked to give written informed consent regarding the use of their video recordings and collected questionnaire data for further analysis. If they had refused, their questionnaire and video recording would have been deleted immediately. However, all of the participants agreed to the use of their data in the context of this experiment. The same option was given to participants in the implicit experiment.

After the FaceReader analyses and the selection of the sections of interest, the results of only 61 participants (average age of 23 years with STD = 3.0 years and 59% female) were usable for statistical analyses. This was caused by problems with the facial expression analyses due to hairstyles covering too much of the face, large amounts of facial hair and participants not facing the camera. Three subjects also forgot to show or showed inconclusive signals when performing their intentional facial expressions; these cases were not used either.

2.3. Experiment 2: implicit measurement of facial expression

2.3.1. Participants and measurements

The 78 participants were students, with an average age of 23 years and STD of 4.0, 54% of them female. The participants were asked to taste the presented 30 ml sample in one swallow, and then think about how much the sample appealed to them for 20 s before answering the sample-related questions. Emotions and the correlated facial expressions have a quick onset, facial expressions can begin in a matter of milliseconds after an emotion-provoking stimulus, and a brief duration (matter of seconds) (Ekman, 1992). Preliminary examinations showed that instructions