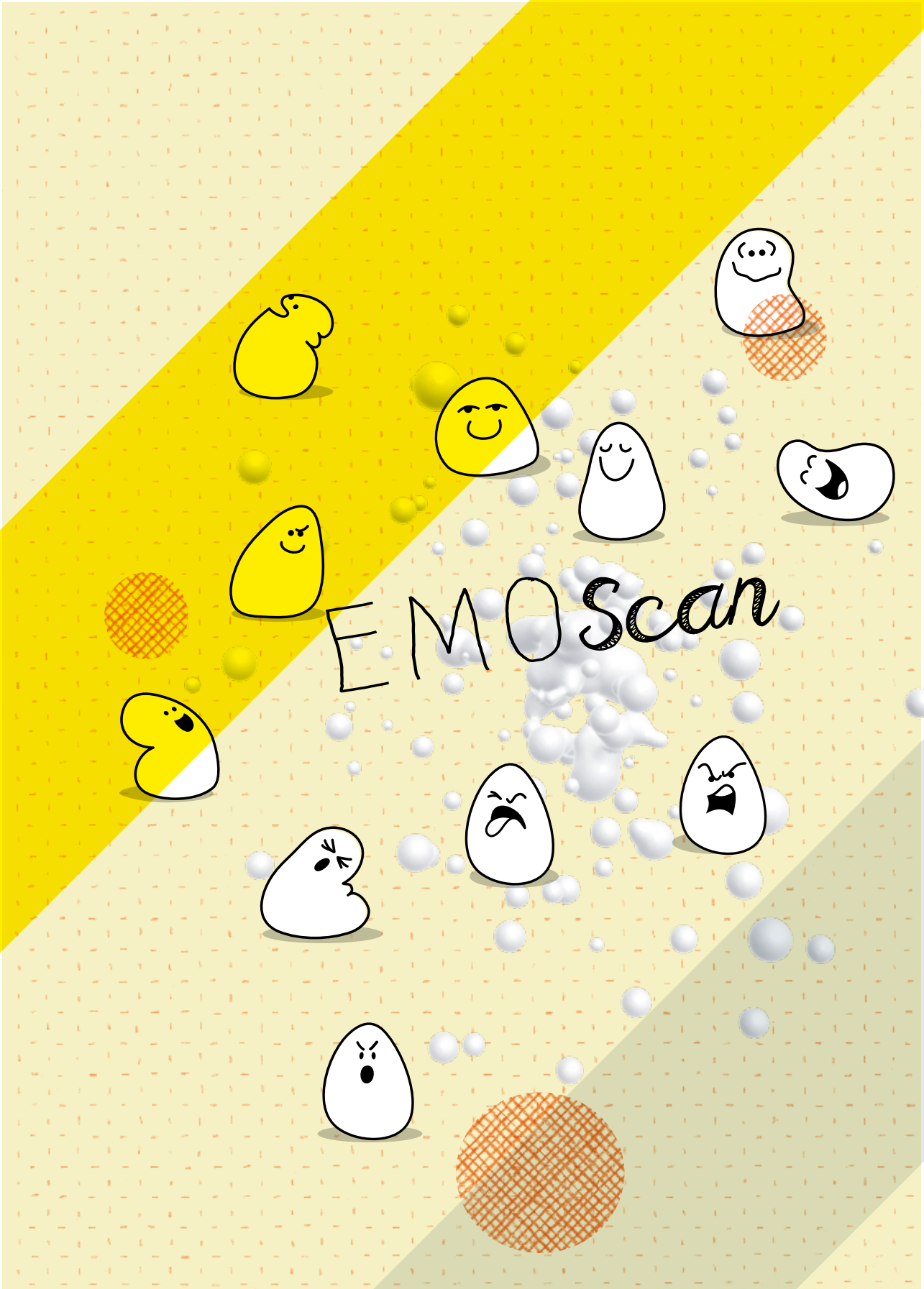

EMOScan

Writ Large on Your Face: Observing Emotions Using Automatic Facial Analysis

Anja Dieckmann and Matthias Unfried

KEYWORDS

Measurement of Emotions, Automatic Facial Analysis, EMO Scan

•

THE AUTHORS

Dr. Anja Dieckmann,
Head of Fundamental Research,
anja.dieckmann@gfk-verein.org

Dr. Matthias Unfried,
Specialist Fundamental Research,
matthias.unfried@gfk-verein.org

both:
GfK Verein, Nuremburg, Germany

Emotions affect all of our daily decisions and, of course, they also influence our evaluations of brands, products and advertisements. But what exactly do consumers feel when they watch a TV commercial, visit a website or when they interact with a brand in different ways? Measuring such emotions is not an easy task. In the past, the effectiveness of marketing material was evaluated mostly by subsequent surveys. Now, with the emergence of neuroscientific approaches like EEG, the measurement of real-time reactions is possible, for instance, when watching a commercial. However, most neuroscientific procedures are fairly invasive and irritating. For an EEG, for instance, numerous electrodes need to be placed on the participant's scalp. Furthermore, data analysis is highly complex. Scientific expertise is necessary for interpretation, so the procedure remains a black box to most practitioners and the results are still rather controversial. By contrast, automatic facial analysis provides similar information without having to wire study participants. In addition, the results of such analyses are intuitive and easy to interpret even for laypeople.

These convincing advantages led GfK Company to decide on facial analysis and to develop a tool suitable for measuring emotional responses to marketing stimuli, making it easily applicable in marketing research practice.

Facial expressions reveal a lot /// Not everyone is an open book from which one can read moods and emotions at first glance. Yet all humans communicate unconsciously, even when they are silent. Back in the 19th century, Darwin investigated the general innate principles that underlie the expression of emotion in humans and animals. Following up on his work in the 1960s and 1970s, Ekman and Friesen studied human facial expressions in many different cultures around the globe. They were able to demonstrate that the facial expressions of the basic emotions joy, surprise, disgust, fear, anger and sadness are universally understood. Based on their observations, Ekman and Friesen developed the Facial Action Coding System (FACS). It encompasses all possible singular movements of the human face, which they called Action Units. To use this system, trained experts need to code the occurrence of each Action Unit manually. This can be very cumbersome: One minute of video recording can take up to one hour of coding, which, of course, severely limits the practical applicability of FACS.

Automatic analysis of facial expressions: Can it really work? /// To nonetheless make use of what our facial expressions reveal, GfK Fundamental Research launched a project with the Fraunhofer Institute for Integrated Circuits and emotion experts from CISA (Centre Interfacultaire en Sciences Affectives) at the University of Geneva, which is headed by Klaus Scherer, a renowned expert on the psychology of emotion. The aim of the collaboration was the development of a software tool for not only detecting prototypical emotions such as anger, surprise, sadness and joy, but also weaker, subtler emotion expressions. These can be observed much more frequently in response to marketing stimuli and thus are of high relevance for market research.

Most of today's affective science researchers no longer consider emotions to be unitary elementary entities. Instead, emotions are seen as complex processes with different components. One fundamental component is the emotional appraisal of the eliciting event. And the good news is: Facial expressions give off clear indications of those appraisals. In the development of our software tool, we therefore focused on the basic appraisal dimensions that underlie all emotions:

- Valence (the intrinsic pleasantness or unpleasantness of an event)
- Novelty (whether an event is new or familiar)
- Control (which measures if an event is clear and easy to understand, confusing or too demanding)
- Arousal (this dimension, unfortunately, does not show in the face)

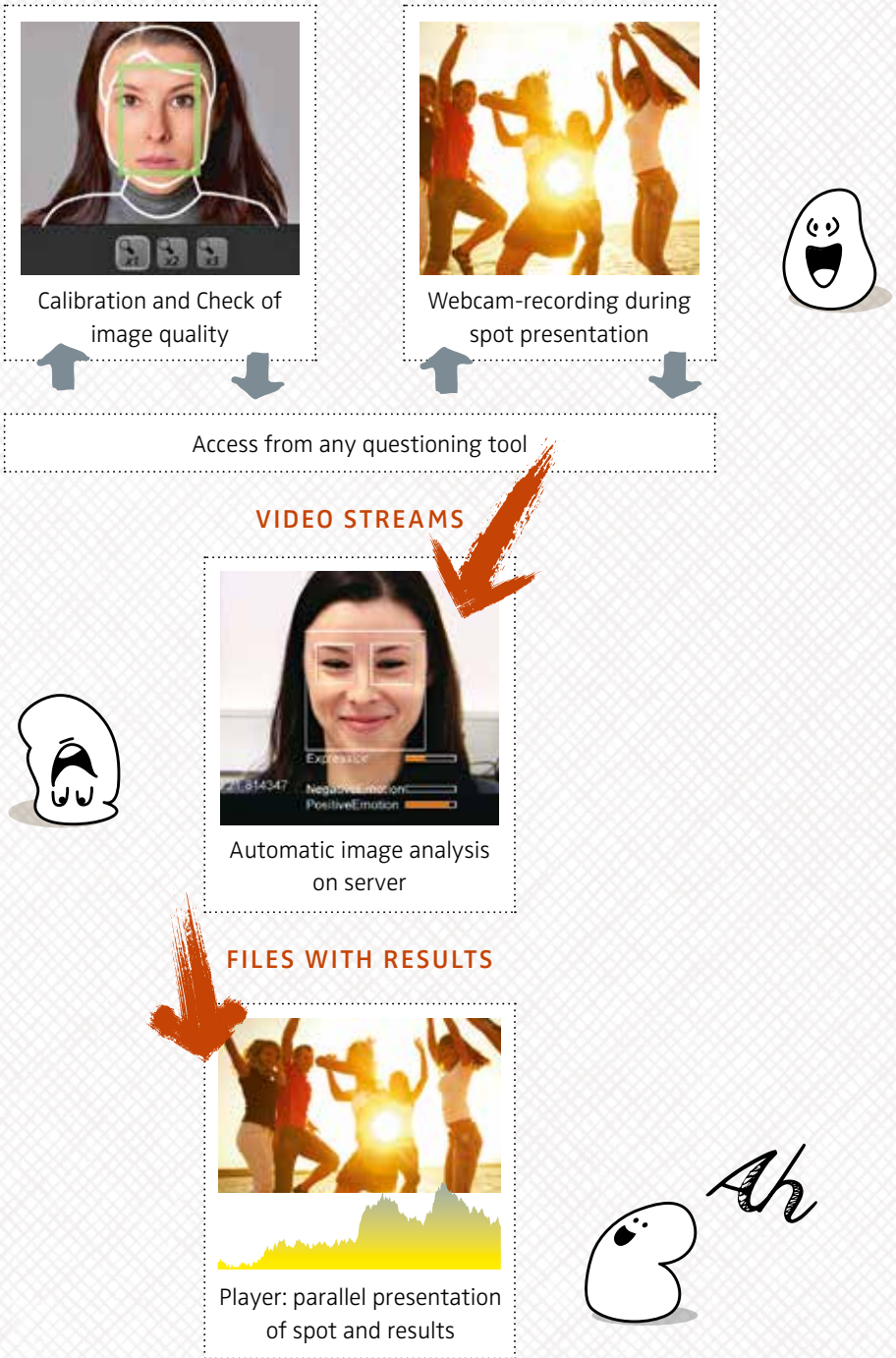
An event that, for instance, is unpredictable and novel, unpleasant and not controllable may result in the specific emotion fear. But given that such clear-cut, basic emotions are relatively rare, many different nuances and shades are possible. By focusing on the basic appraisal dimension, facial expression analysis can deliver continuous results that are more easily traced over the course of watching marketing stimuli such as TV commercials.

What can EMO Scan deliver and how does it work? /// The current version of our software is called EMO Scan and infers from respondents' facial expressions the valence of an emotional reaction, that is, the extent to which a stimulus is perceived as pleasant or unpleasant. The software has been trained with a large data set comprising more than 12,000 pictures of different positive and negative faces. It identifies the facial regions pixel by pixel that best discriminate between positive and negative emotions. New faces, such as from video recordings of respondents, are then compared to the faces from the data set in these critical face regions. The output is a numerical value assigned to every recorded video frame that indicates the typicality of the recorded facial expression by comparing it with the positive and negative faces in the training data set.

Analysis on secure GfK servers is fully automated, thus preserving participant anonymity. Figure 1 shows the typical analysis process. With the participant's explicit consent, video recording and upload can begin. The initial step consists of calibration and quality control. In step 2 the participants watch a TV commercial while their facial expressions are recorded. In step 3 the software analyzes those facial expressions. Subsequently, the video is deleted and only its results – the valence scores – are retained. Final (step 4) results can be visualized with a special player.

FIGURE 1:

Automatic facial expression analysis with EMO Scan



Is the output of EMO Scan reliable? /// To test the validity of EMO Scan, we conducted an empirical study with 180 respondents. The respondents were shown four different TV commercials and 32 pictures from the standardized International Affective Picture System (IAPS), half of which elicit positive and half of which elicit negative emotional responses.

While watching the TV commercials and looking at the pictures, the study participants' faces were recorded with a webcam. The recordings were subsequently analyzed with the software. Participants were additionally asked to rate each picture in terms of how they felt while viewing it (picture rating). Validity was evaluated based on three criteria:

1) To what extent can the picture valence according to the objective IAPS classification be predicted based on the results of the EMO Scan software?

2) To what extent can EMO Scan results explain differences in individual picture ratings?

3) How well do EMO Scan results fit the storyline of the TV commercials?

In terms of the first criterion, the prediction of the pictures' IAPS classification, EMO Scan showed excellent performance. For all pictures, the hit rate was 75 %. Focusing only on the pictures with average valence scores of more than one standard deviation above or below zero, the hit rate even increased to 100 %.

To judge the explanatory power of EMO Scan, valence scores for the individual picture ratings (criterion 2), different regression analyses were conducted. In all cases EMO Scan valence scores contributed significantly to explaining individual picture ratings.

The software also achieved compelling results in terms of the third criterion: Due to the high temporal resolution, the captured emotional responses can be very precisely assigned to the different scenes in a spot – and with a high fit in terms of face validity. Figures 2 and 3 show the results for two of the four TV commercials as examples. For the funny car commercial, average valence is positive throughout the whole timeline. The first rise happens when the first celebrity is shown and the music begins. The two punch lines entail significant rises of the valence curve, that is, they clearly result in positive emotions that last until the end of the spot (cf. Figure 2).

The valence for the toothpaste spot shows clear dips into the negative range at the beginning. These are the results of two shock effects at the beginning of the advertisement. Although factual information and problem solution are presented in the second half of the commercial, valence stays in the negative range (see Figure 3). The conclusion is that in this case most respondents disapprove of the underlying marketing strategy based on provoking disgust and fear.

The impressive results above show that EMO Scan findings are valid and deliver valuable information for optimizing TV commercials.

In addition to the validity checks described above, we measured participants' electrodermal activity during their exposure to the stimuli in cooperation with Prof. Andrea Gröppel-Klein from Saarland University. The results showed temporal correlation of the EMO Scan results with the galvanic skin response, an indicator of emotional effects. This is additional proof for the validity of the EMO Scan measure.

»
This procedure of facial analysis
can provide valuable
insights whenever emotional reactions
play a major role in the
evaluation of marketing activities.
«

FIGURE 2:
Average valence during the humorous car commercial

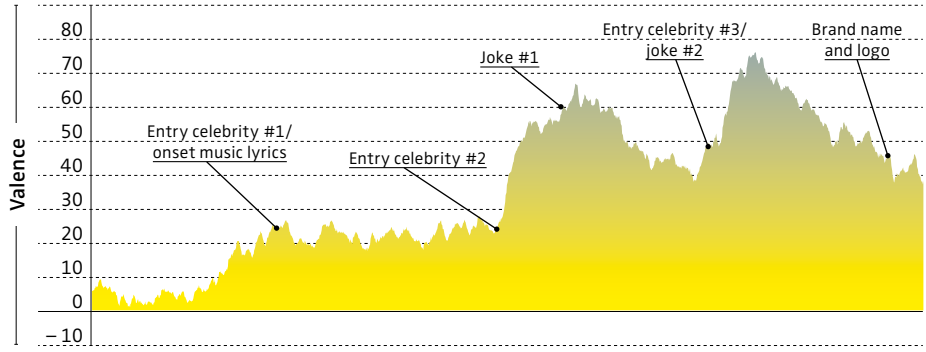
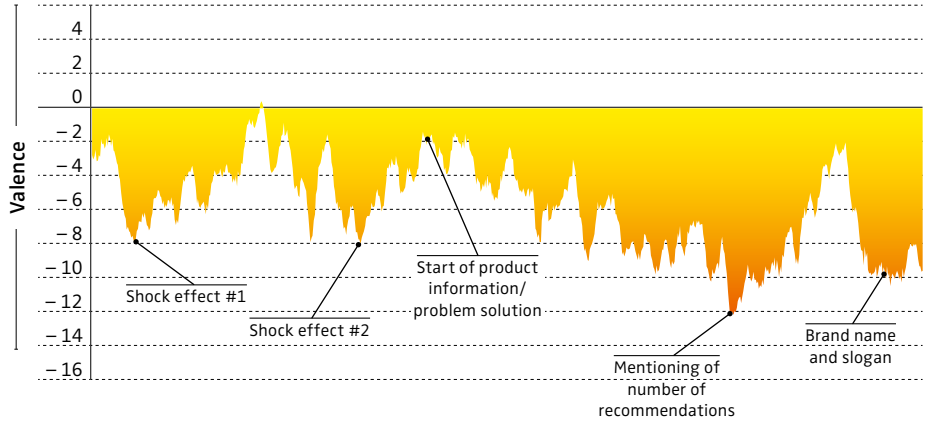


FIGURE 3:
Average valence during the fear-appeal toothpaste commercial



Applications for EMO Scan /// The procedure of facial analysis outlined here can provide valuable insights whenever emotional reactions play a major role in the evaluation of marketing activities. GfK EMO Scan has already been successfully used in several studies of diverse brands. In addition to tests of commercials for German cars and French cosmetics, it was used for tests of automobile designs and TV programs. The software seems to offer a very promising practical addition to conventional surveys for the following applications:

- ***Optimizing promotional material*** /// The software can be used to test commercials, print advertisements and what is known as eDetailing material. EMO Scan can also be utilized when testing television programs or any form of communication media.

- ***Usability research*** /// Furthermore, the technology holds a lot of promise for usability research for websites, software and consumer electronics. Confusion, lack of understanding or frustration can be detected very well in survey participants' facial expressions. Therefore, facial analysis can also help to develop more intuitive and easier to use devices and applications for consumers.

And what to expect next? EMO Scan 2.0 ... /// The new version, 2.0, which will provide additional dimensions of emotional appraisal, will reach the market soon. The appraisal dimensions "Novelty" and "Control" will be added to the set. The latter dimension in particular should prove valuable for usability tests. Future analysis will no longer be based on pixel-level comparisons with large databases. Instead, individual facial expressions will be analyzed according to characteristic muscle movements of single action units. We are starting with nine important action units in which emotions frequently manifest as mimic expressions. Examples for such action units are the furrowing of the brows or the wrinkling of one's nose. In time, the number of action units will be expanded.
/.

FURTHER READING

Ekman, P. and Friesen, W. (1978):
Facial Action Coding System:
A Technique for the Measurement of Facial Movement.
Palo Alto: Consulting Psychologists Press.

Scherer, K. (2005):
"What Are Emotions?
And How Can They Be Measured?"
Social Science Information,
Vol. 44, No. 4, pp. 695 – 729.

Garbas, J.-U.; Ruf, T.;
Unfried, M. and Dieckmann, A. (2013):
Towards Robust Real-time Valence Recognition from
Facial Expressions for Market Research Applications.
Proceedings of the 5th International
Conference on Affective Computing and Intelligent
Interaction, pp. 570 – 575.