

decode Science Update 2_2013

Does facial expression = emotion?

A scientific perspective on new methods of measuring emotions

September 2013

Welcome to the decode Science Update

Emotions play a central role in marketing. Building up an emotional connection to the customer, whether this is by means of packaging design or the nature of a commercial, is the intended objective of many projects and briefings. In the light of this, it appears logical that there is currently a great deal of hype about methods of measuring the emotional reaction of consumers.

As reflective ("rational") access to emotions appears to be largely invalid, particular attention is on procedures which measure emotional reaction without relying on self-reporting by the consumer. These include EEGs (recording electrical activity in the brain) and measuring the electrical resistance of the skin, but both methods require apparatus and can be rather time-consuming to implement. It is therefore even more exciting to note that there are now processes **which can automatically determine emotional reactions via cameras and even web cams without asking** the consumer to do anything. The underlying principle is this: software determines the emotion shown by the person at a particular moment, solely based on the facial expression measured by the web cam.

That we have no need to ask consumers about their emotions, but are instead able to measure these directly, automatically and implicitly sounds extremely appealing, especially as at first glance this appears to be a more valid and objective methodology. It is therefore hardly surprising that many market research companies now offer this kind of emotional measurement.

Using up-to-date findings from neuroscience and psychology, this science update puts so-called facial expression tracking under the microscope: what are the fundamentals, what can they do, what can they not do and are the procedures valid? The latest research findings illustrate the link between facial expressions and emotion and also offer insights into cultural differences.

We hope you enjoy reading this update
Your decode Team.



Dr. Christian Scheier

Dirk Held

PD Dr. Martin Scarabis

Johannes Schneider

Dr. Dirk Bayas-Linke

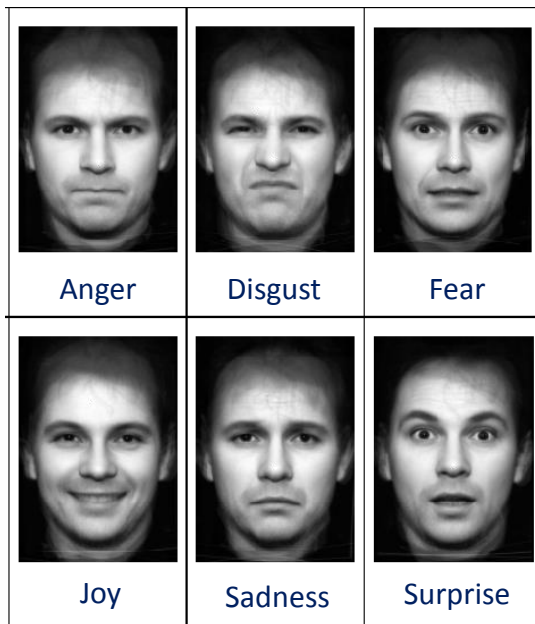
Dr. Björn Held

Tobias Eckert

Juliane Matussek

Basis #1 - Theory of Basic Emotions

The approach of using facial expressions to measure emotions is based on the theory of basic emotions postulated by psychologist Paul Ekman (whose [emotions theory](#) extends far beyond the scope of these basic emotions). According to this theory, there are six basal emotions: Joy, surprise, sadness, anger, disgust and fear*. According to the theory, these are universal, innate and independent of cultural influences.



Most studies of recognising emotions in faces are based on a so-called *forced choice* method. In this case subjects decide which of the six emotional labels (anger, fear etc.) appears to be the best fit. Results show that adults can consistently assign labels to facial expressions, and that this is replicated worldwide.

This lends credence to a theory which was already stated by Charles Darwin i.e. that assigning emotions to facial expressions is universal and hence independent of cultural influences.

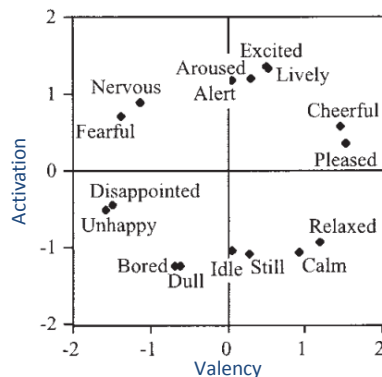
These results also suggest that these emotions are combined with corresponding facial expressions, otherwise how could we assign emotions to faces? **If we are happy about something, then the joy is expressed in our facial expression and hence conclusions can be drawn about the basic emotion by means of measuring the expression on the face.** This context serves as the basis of *facial expression tracking*.

* Contempt is sometimes counted as a seventh basic emotion. Other researches differentiate between up to 10 basic emotions, including jealousy and love.

Basis #2 - Valence and Activation

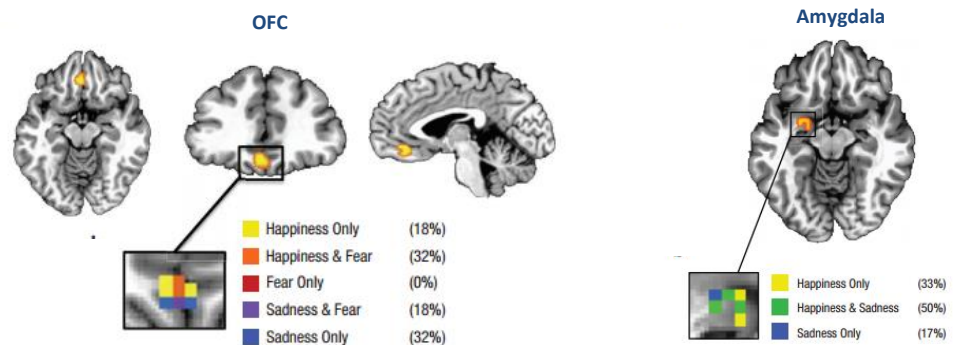
A look into emotions research shows that there is an alternative view of emotions which is well-founded in neuroscience and psychology. According to this *dimensions theory* of emotions **two basic dimensions** determine our emotional world: **Valence** (pleasant/unpleasant) and **Activation** (active/passive). All basic emotions, according to this theory, can be understood as mixtures of these two basic dimensions. For example, disgust would be strongly towards *unpleasant* and relatively neutral on a spectrum between *active / passive*. Fear is unpleasant and activating, joy is pleasant and activating. Many research findings consistently show that people organise their emotions in accordance with these two basic dimensions. If people are left to sort out emotional expressions (see picture A), the expressions are organised along the two dimensions of valency and activation. Also, [current neurological findings](#) are consistent with the dimensions theory (see picture B). According to these findings, **the orbitofrontal cortex (OFC) determines valence and the amygdala determines activation** - both areas of the brain become active when we experience emotions such as joy, fear and sadness, but each in different degrees. The OFC encodes valency in a gradient from top to bottom: Neurons located near the top fire with positive emotions, whereas those nearer the bottom (*inferior*) fire with negative emotions. However, there is no *joy* or *sadness* module within the brain.

A. People organise emotional expressions along a spectrum of valence and of activation



Source: Barrett, L. F. (2004). Feelings or words? Journal of Personality and Social Psychology, 87, 266-281.

B. Two areas of the brain react no matter whether we experience joy, anger or sadness: the orbitofrontal cortex in the lower frontal lobe encodes valency (positive/negative) and the amygdala encodes the activation that was felt.



Source: Wilson-Mendenhall et al. (2013). Neural Evidence That Human Emotions Share Core Affective Properties, Psychological Science 24(6) 947-956

This view of emotions can also be found in several pretests: Activation and valence are measured so that the emotional reaction of consumers is measured (even if it is mostly based on questioning the test subjects). **As well as the basic emotions, the basic dimensions of valence and activation are also key for measuring emotional reactions to touch points.**

How facial expression tracking works

According to Ekman's theory, the six basic emotions are expressed in the face. **By measuring facial expressions we can determine which emotion a person is feeling when watching an advert.** This was only previously possible by means of time-consuming processes (e.g. manual encoding of facial expressions, measuring facial movements with EMG). Thanks to web cams and improved algorithms for visual recognition of faces/facial movements it has been possible to circumvent such issues for some time. In the meantime there is now a large selection of suppliers who have developed (or licensed) software in order **to simply measure the facial expressions of people by web cam** and then draw conclusions on the emotions upon which these expressions were based. This *emotion tracking* is currently being massively hyped.

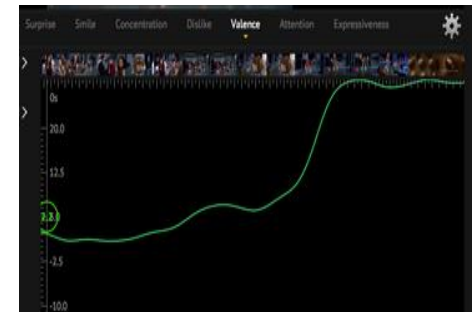
Touchpoint exposure

- TV commercials
- Web commercials
- Websites
- Mailings
- POS
- ...

Measuring facial expression during exposure

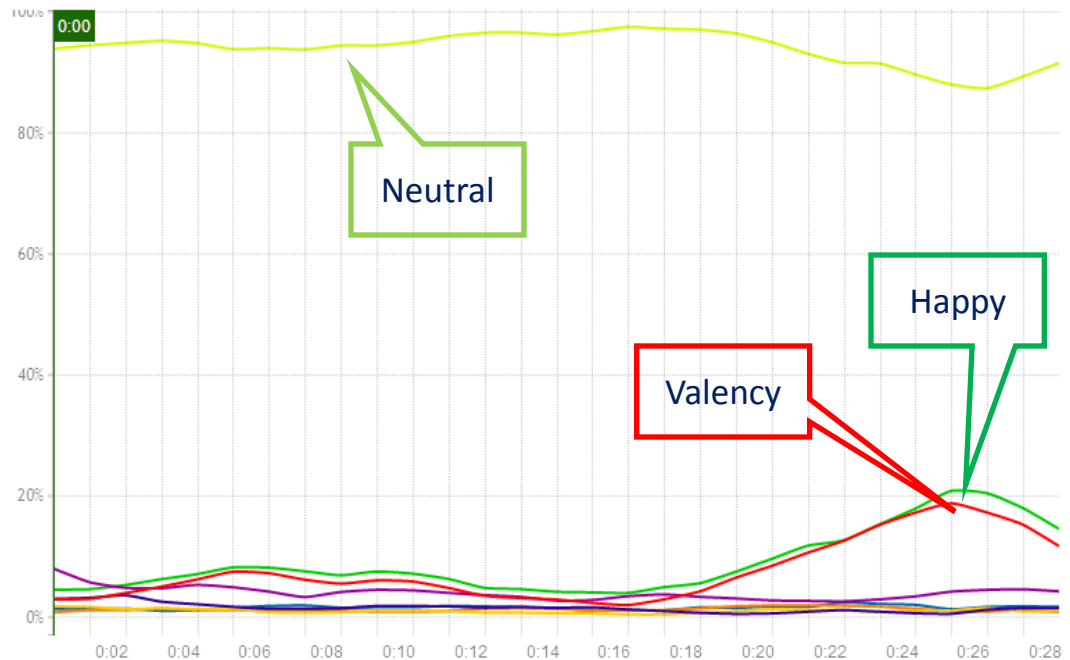
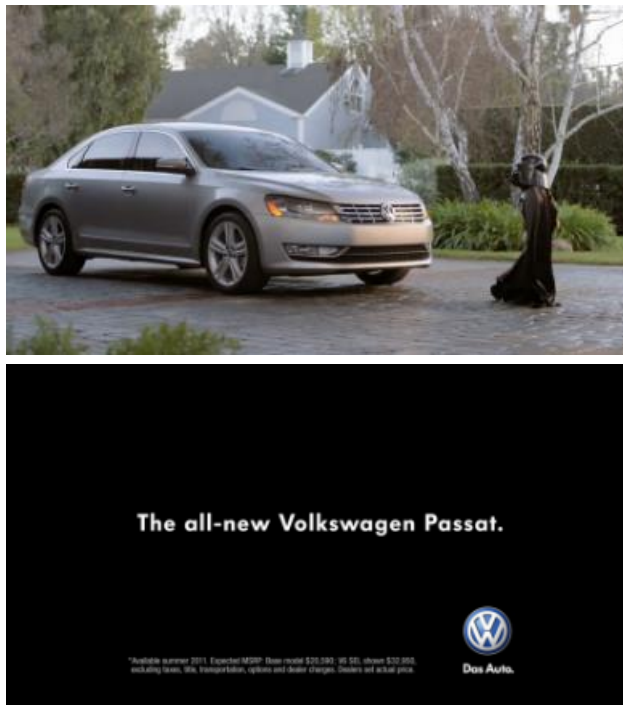


Measuring emotional reaction (valency, activation) & basic emotions (joy, anger,...)



Example: What does a result look like?

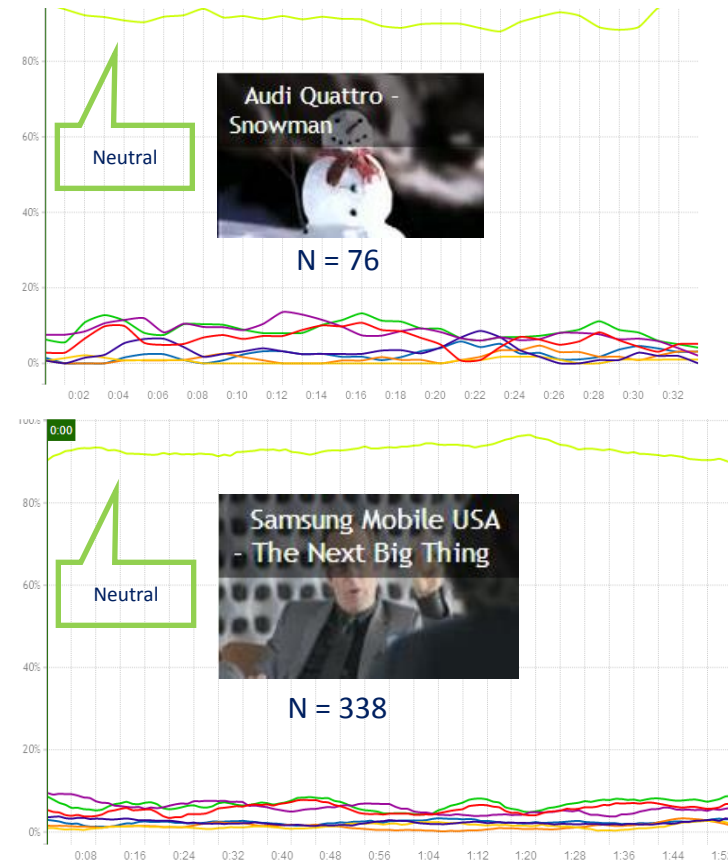
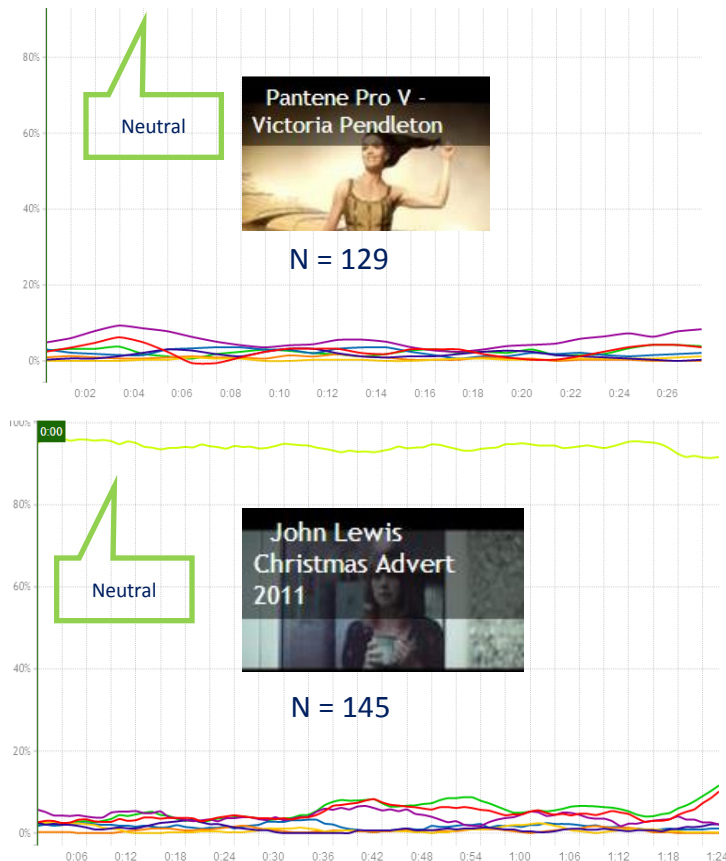
Several suppliers of facial expression tracking solutions offer online demonstrations, usually with commercials. Generally, the demos show the combined test results of many test subjects to the respective commercials. Let's take a look at a few examples from realeyes.com. The first is one of the most famous and successful commercials of the last few years. In the Volkswagen commercial *The Force*, a child dressed as Darth Vader uses his *magical powers* on the new VW Passat. When looking at the results based on 535 people, the following becomes apparent: **The dominant emotion is the neutral state** (light green curve at the top of the picture below) i.e. there is no obvious emotional reaction and the software had classified the facial expression as *neutral*. A rise in the *happy* emotion (= smiling) can only be seen at the end of the commercial and the valency curve (red curve) rises accordingly. On the other hand, all other emotions do not seem to play a part at all. Admittedly, considering the narrative arc of the commercial, this does make sense: At the beginning of the commercial very little happens and it only becomes amusing at the end.



TV commercial *The Force* (VW) ; N = 535 people measured

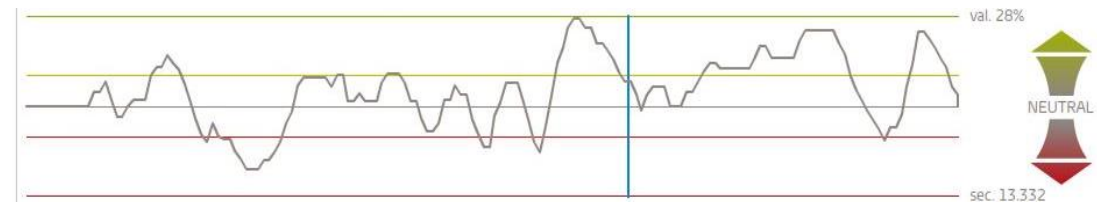
Further examples of results

What do the curves look like with other commercials and product types? When looking at the profiles (see below) the following becomes clear: In well over 95% of the duration of the commercials tested, the *neutral* facial expression is dominant. **All basic emotions, including joy and surprise, barely register.** For negative emotions, these results are hardly surprising as (with few exceptions) it is not the intention of a commercial to trigger negative emotions. However, positive emotions barely register either. It goes without saying that this could be down to the commercial, but this pattern was replicated in almost all of the commercials stored (> 30 commercials). Besides, this generally low level of response was certainly significant, since most commercials aim to create an emotional reaction.



Facial expression tracking: Signal to noise ratio

The VW commercial *The Force* shows an increase in *joy* of c. 20 percent. Nevertheless, as we have already seen, the neutral reaction is predominant. In the light of the impact this commercial has had (over 50 million downloads on YouTube plus various awards), it is surprising that there is such a high proportion of neutral facial expressions, i.e. faces which do not show significant emotional reaction. In order to investigate the question of what a 20 percent increase is actually worth, we need to better understand how exactly the measurement of facial expressions via web cams takes place. We have carried out a simple test for this purpose: Instead of having a real person in front of the web cam, we carried out a test with a doll. As the doll obviously doesn't move any facial muscles, one would expect that the software would not register any fluctuations.

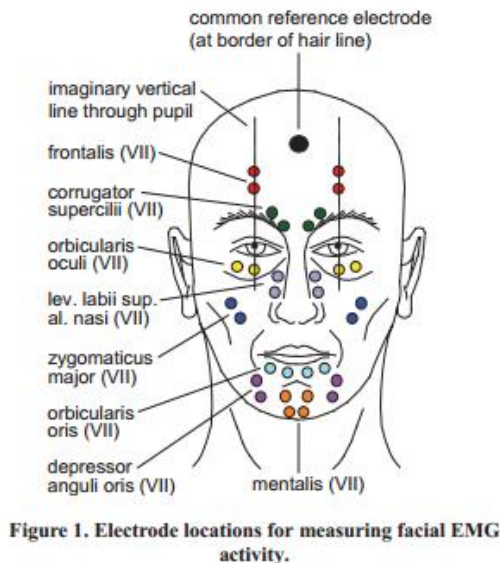


Emotional reaction (valence)

The result is surprising: **Although a doll is being used, the facial recognition software shows noticeable deviations regarding valency.** The increase of the (alleged) level of happiness reaches a maximum of 28 percent. Or, expressed differently: random fluctuations of up to (in this case) more than 25% of the entire scale occur during measurement. In the light of this, the peak noted in *The Force* commercial is below the range of variation - even if the cause of this appears plausible. It is perfectly normal for *noises* - random fluctuations - to occur when taking measurements with a web cam. However, **this result shows that caution is required when interpreting results and that it is recommended to determine the signal to noise ratio of the respective software packages precisely (e.g. via a static doll test).**

Facial expression tracking using EMG

Now, the question is: is the fact that none of the basic emotions appear significantly caused by the web cam measurement, or is there something wrong with the underlying theory? Let's take a look at whether it is a problem with measurement. The most precise method of measuring facial expressions is so-called EMG (electromyography). Electrodes are attached to the facial muscles, and these electrodes are capable of picking up the tiniest movements which cannot be detected by the human eye.



Measuring facial expressions with EMG

Can EMG be used to differentiate between individual emotions in facial expressions? Researcher Anton van Boxtel from the University of Tilburg summarised the main answers to this question in a [survey article](#) as follows:

"Reliable discrimination between specific positive or negative emotions on the basis of facial EMG response patterns remains complex as yet. A limitation of EMG recordings (...) of emotional processes is that the human face does not only display affective responses but also produces a large variety of activities unrelated to emotional processes (...) the influence of such ubiquitous factors should be carefully evaluated to avoid invalid conclusions regarding a person's affective state." (van Boxtel, 2010)

Even with EMG, the most precise method of carrying out such measurements, it is extremely difficult to measure specific emotions based on facial muscles and facial expressions. In principle, it also appears difficult to deduce specific emotions such as anger, sadness or joy by means of an algorithm of facial expressions.

Source: van Boxtel, A. (2010). Facial EMG as a Tool for Inferring Affective States. In: Proceedings of Measuring Behavior 2010 (Eindhoven, The Netherlands, August 24-27, 2010) 104, Eds. A.J. Spink, F. Grieco, O.E. Krips, L.W.S. Loijens, L.P.J.J. Noldus, and P.H. Zimmerman.

Facial expressions are not obvious (1/2)

When measuring emotions on the basis of facial expressions, the methods used quickly reach their limits. So, what about the theoretical basis of basic emotions? In Ekman's experiments, the test subjects were presented with pictures of faces to which they had to assign words describing the emotions (forced choice). They succeeded in doing this with high consistency.

In these experiments facial expressions were used which were highly exaggerated and *consciously* produced by actors who were given the objective of expressing the particular emotion (e.g. joy, anger, surprise) - in a similar way to how they appear with cartoon characters or caricatures. However, does this reflect reality? In everyday life we deal with **spontaneous facial expressions which are rarely so obvious**. Take a look at the left-hand picture below - what emotion is she feeling? One might suspect that she is feeling pain. However, a look at the context (below right) makes it clear: Her face is expressing (ecstatic) joy.



Source: Barrett et al. (2011). Context in Emotion Perception, Psychological Science.

A series of more recent investigations have actually shown the following: **mostly we can't simply read emotions in a face, like we can read a word. Instead, the emotion only becomes clear through context (e.g. gestures, location)**. Let us look at this more closely.

Facial expressions are not obvious (2/2)

The same facial expression is shown in the four pictures below, but depending on the context (in this case: gestures) the emotion is judged quite differently by test subjects. This was demonstrated by a group of scientists working with the psychologist [Ran Hassin](#) in a series of experiments. The "correct" emotion - disgust in this case - was only correctly assigned to picture (a). The test subjects assigned the same facial expression in picture (b) to *anger* based on the context (a raised fist). In addition, eye tracking studies show that the context also influences which aspects in a face are taken into consideration, i.e. how the face and the facial expression is processed and interpreted.

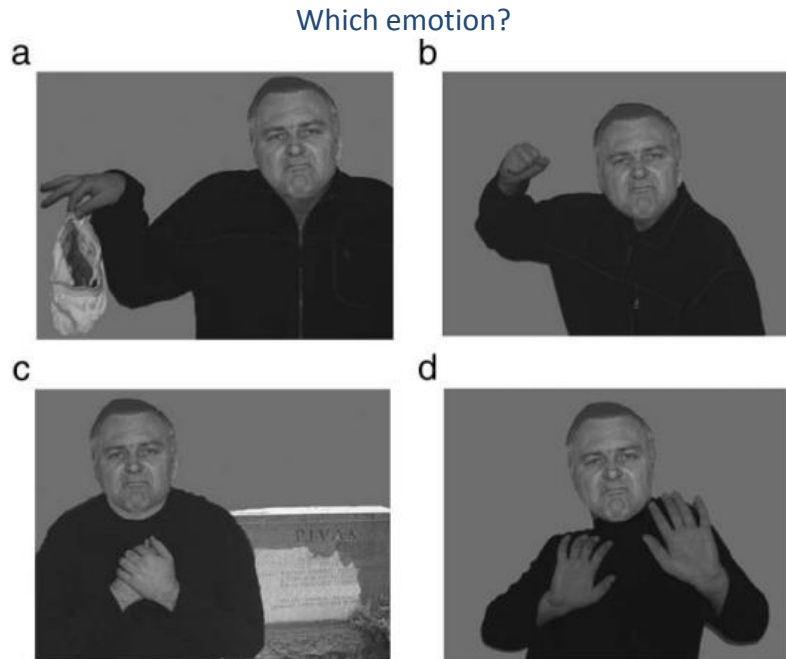


Fig. 1. Examples of stimuli exhibiting four levels of perceptual similarity between the target face and the facial expression typically associated with the context. In Experiment 1, identical disgusted faces appeared in contexts of (a) disgust (full similarity), (b) anger (high similarity), (c) sadness (medium similarity), and (d) fear (low similarity). All facial expressions are reproduced with permission from the Paul Ekman Group.

The conclusions of the researchers are: "(...) we found that the mapping of facial expressions to emotion categories can be influenced strongly by bodily and scene context, even at early stages of perception. Our results contrast with the discrete-category view in that we found that facial expressions can be perceived as conveying strikingly different emotions depending on the bodily context in which they appear (...)

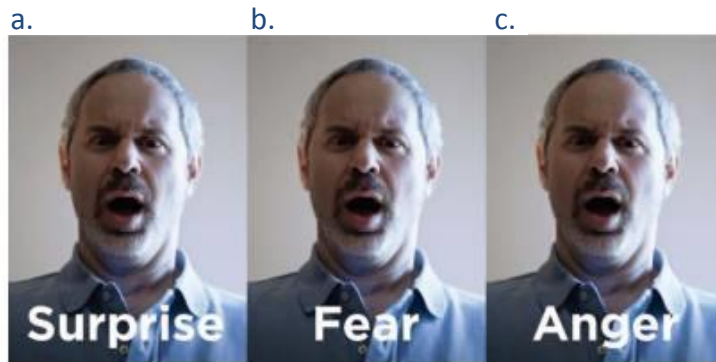
From an evolutionary standpoint, it seems safe to assume that our ancestors had no exposure to isolated facial expressions. It is thus implausible that our ability to recognize facial expressions and map them into emotion categories evolved in complete isolation from our ability to recognize the context in which the faces are embedded."

The primary assumption of facial expression tracking, that we can decipher the emotions of another person based on facial expressions alone, appears questionable in the light of current results.

Facial expressions are interpreted actively

When we look at emotions in peoples' faces it can feel *as if* we were reading a word on a page. In many studies, this is precisely what is happening: The participants read the emotion on the label (joy, anger etc.) and then assign it to a facial expression. What role do these labels play? They deliver contextual information regarding the face's visual signals. The research group of emotional psychologist Lisa Fieldman Barrett summarised the key insights in their survey article *Context in Emotion Perception*: If labels are not issued and test subjects are asked to use their own expressions for the respective facial expressions instead then the accuracy of recognising basic emotions in faces drops dramatically (to 57 percent compared to 83 percent when using labels). If the test is carried out completely without expressions and the participants are asked to simply sort out the pictures based on the similarity of emotional expression (e.g. if two disgruntled faces resembled each other) then accuracy falls to 42 percent. Furthermore, if tests are carried out which make it tougher to access emotion labels (so-called verbal load), then accuracy falls to 36 percent.

Emotional labels such as *surprise* or *fear* therefore help when interpreting a facial expression. If such labels are not present then there is less agreement because the facial expressions can be interpreted differently. **This means that a facial expression is not an objective message relaying the actual emotion, but that the observer actively interprets the facial expression shown.** As we have already seen, the context (e.g. gestures) also plays a part.

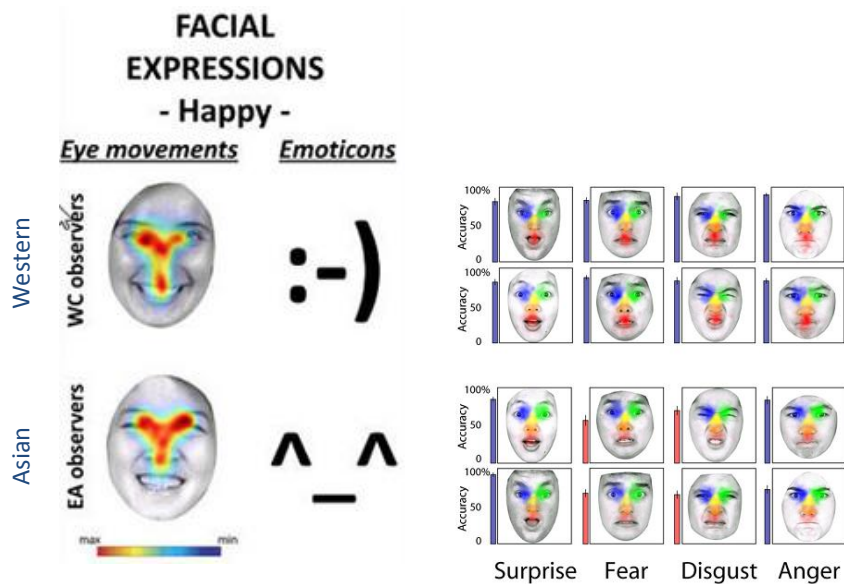


The example on the left shows clearly that there is leeway to interpret facial expressions differently. If we look at the combination of facial expression and a label with an emotion on it from (a) to (c) then it becomes clear that the same facial expression can apply to completely different labels (in this case surprise, fear and anger). Only the context makes clear which emotion is the *correct* one.

The emotions that, for example, our partner feels are interpreted by us as the observer and are not in any way objective information. This has to be taken into consideration when looking at any approach that claims that determining specific emotions via facial expressions is *objective* and unambiguous.

Cultural influences in facial recognition

A further key assumption of the theory of basic emotions, or the corresponding software algorithms for recognising emotions in faces, is that facial expressions are understood universally. Current studies from several research groups show that there are **definitely cultural differences when decoding faces and facial expressions**.



WC = Western Caucasian / EA = East Asian

Source: Jack et al. (2009). Cultural Confusions Show that Facial Expressions Are Not Universal. Current Biology 19, 1543 – 1548.

The psychologist Rachael Jack from the University of Glasgow was able to show that **Asian people tended to consider faces differently compared to Western test subjects, and to determine emotion based on different characteristics**. As can be seen from the pictures on the left, Asians pay noticeably less attention to the mouth area compared to Western test subjects. Interestingly, this is also mirrored in emoticons: In the West, a smiley is defined by the mouth, but in Asian countries it is the eyebrows (and not the mouth) that express joy.

A further indicator of cultural influence comes from the field of developmental psychology. Studies of infants and children show that they only become able to recognise specific emotions in faces over time. So, at the age of 2 years children can reliably recognise joy, but are not yet capable of correctly identifying exaggerated facial expressions indicating surprise or anger. The focus is more on basic dimensions, especially valency (whether the emotion is positive or negative). At the age of 9 about 50% of children can correctly identify disgust. When the connection between facial expressions and assigned emotion is learned, it becomes plausible that cultural differences exist.

Conclusion & implications (1/2)

The objective of this Science Update is to put facial expression tracking (or emotions tracking) via web cam to the acid test using insights from research into emotions. Our conclusion is somewhat sceptical:

- Algorithmic **measurements of specific emotions** (basic emotions such as joy, sadness or anger) **based on facial expressions appears to have both theoretical and methodological problems.** On the one hand, the basic emotions are not objectively present in a facial expression, but arise through interpretation by the observer. On the other, the measurement is occasionally difficult to interpret and is currently limited to the most accurate method (EMG) under laboratory conditions.

- According to the current state of research, valency** (positive/negative) **and activation** (active/passive) **can be measured validly.** These two aspects can be validly reported by people in surveys - the correlation with more implicit measurements (e.g. skin resistance, facial expression) is high, especially for the valence of stimuli (e.g. TV commercial). Well-established and validated scales (e.g. the PANAS scale) and tools are available for evaluating changes in valency in the course of a commercial (e.g. using a slider or a mouse). The added benefit of *facial expression* tracking is, ideally, that valency and activation can be measured without the test subject being involved in the process (provided that the respondent has a web cam and permits access and recording). **In any case, such software must be thoroughly tested (e.g. signal to noise ratio) and the results for a neutral facial expression should also always be obtained.**

- As facial expressions are actively interpreted by the observer, the assignment of facial expressions to basic emotions using software may succeed if the software is *trained* in advance based on facial expressions which are assigned to the corresponding emotions by experts. The software learns which facial expressions *belong* to which emotion label in the same way a small child does.

- If we assume that basic emotions can be reliably identified by software algorithms in the future - how useful is the resulting information in day-to-day marketing activities when the predominant facial expression observed when watching emotional commercials is neutral, or if it cannot be readily assigned to one of the basic emotions?

Conclusions and Implications (2/2)

- The theory of basic emotions also demonstrates a large barrier within marketing: If companies brief their agencies to create *emotional* designs and commercials then, according to the theory of basic emotions, the agency only has two options for showing positive emotions: Joy and (positive) surprise. This inevitably reduces differentiation. Furthermore, in the case of packaging design, how does one convey joy or surprise? 'Emotionalisation' as an objective is extremely imprecise and barely differentiates. Whether the resulting creation is experienced positively is a hygiene factor which can just as easily be found out by means of questioning. The key question is *why* a creation is experienced in a positive or negative manner, and whether the reasons why are relevant and play a part in the purchasing process. In this case the emotion, or the liking of a creation, is of lesser importance compared to motivation (wanting), i.e. whether the experience motivates the observer to buy, or repeatedly buy, the brand or the product.

Further reading

- You can find a wide range of scientific articles on this topic on the www.affective-science.org website.
- An excellent summary regarding the current discussion on basic emotions can be found in the Boston Magazine: [About Face](#).
- Overview of measuring emotions: Mauss, I.B. (2009). [Measures of Emotion: A Review](#). Cognition and Emotion, 23(2),209-237.
- Influence of emotion labels on the interpretation of facial expressions:
 - Gendron, M. et al. (2012). [Emotion Words Shape Emotion Percepts](#). Emotion, Vol. 12, No. 2, 314 – 325
 - Fugate et al. (2010). [Reading Chimpanzee Faces: Evidence for the Role of Verbal Labels in Categorical Perception of Emotion](#). Emotion, Vol. 10, No. 4, 544 –554.
- Influence of culture on interpreting facial expressions:
 - Barrett, L.F. & Kensing, E.A. (2010). [Context Is Routinely Encoded During Emotion Perception](#). Psychological Science, 21(4) 595–599
 - Aviezer, H. et al. (2011). [Angry, Disgusted, or Afraid? Studies on the Malleability of Emotion Perception](#). Psychological Science.
 - Barrett, L.F. et al. (2011). [Context in Emotion Perception](#). Current Directions in Psychological Science. 20(5) 286–290.
- Influence of culture:
 - Jack, R.E. (2012). [Facial Expressions of Emotion are not Culturally Universal](#). Proceedings of the National Academy of Sciences of the United States of America.
 - Jack, R.E. (2012). [Internal Representations Reveal Cultural Diversity in Expectations of Facial Expressions of Emotion](#). Journal of Experimental Psychology: General. Vol. 141, No. 1, 19–25.

Recommended events with decode lectures



decode lecture:

"Neuromarketing: consumer insights from the brain. What is neuromarketing and how can retailers profit?"

Phil Barden (decode UK)

Amsterdam; October 3rd, 2013

<http://www.neuroretailrevolution.com/en>

decode lectures

- September 25th, 2013 – Phil Barden / decode UK
Warc's 11th annual Advertising Research conference
Topic: *CASE STUDY: Researching the Implicit Memory to Optimise Advertising Effectiveness at Heineken.*
London
- 28th, September 2013 - Dr. Christian Scheier / decode Managing Director
Petersberger Gespräche (conference) 2013
Topic: *The next revolution will not be technological, but psychological in nature.*
Bonn
- October 28th, 2013 – Johannes Schneider / decode partner
16th VLB-Forum for the drinks industry and the drinks trade
Topic: *Gut feelings in the head - impulses from (neuro-)psychology on the effect of codes.*
Berlin
- November 18th, 2013 – Dr. Christian Scheier
Conference Return on Advertising – Measuring and evaluating the effects of advertising.
Topic: **How advertising works - Insights from neuropsychology**
Hamburg
- November 28th, 2013 – Dr. Christian Scheier
40th German Marketing Day
Topic: *How customers really decide: Current insights from neuropsychology*
Düsseldorf

decode open seminars & events

Open Seminar

- 5th - 6th December 2013 – PD. Dr. Martin Scarabis / decode partner
ZFU International Business School
 Topic: **Neuromarketing in practice: What your customers really want. Exploit the full potential of your touch points.**
 Zürich

Current scientific publications

- **PD Dr. Martin Scarabis** (in collaboration with Caltech, USA and the universities of Mannheim and Vienna)
 Genschow, O., Florack, A., Chib, V. S., Shimojo, S., Scarabis, M., & Wänke, M. (2013). Reaching for the (product) stars: Measuring recognition and approach speed to get insights into consumer choice. *Basic and Applied Social Psychology*, 35, 298-315
<http://www.tandfonline.com/doi/full/10.1080/01973533.2013.785399#Uhcrgz-lc1>
- **PD Dr. Martin Scarabis**
 Büttner, O.B., Florack, A. & Scarabis, M. (2013). Advertising Communication. In: Blanz, M., Florack, A., & Piontkowski, U. (editors) (2013). *Communication: An interdisciplinary introduction*. Kohlhammer: Stuttgart.

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decode Marketingberatung GmbH

Graumannsweg 19
D – 22087 Hamburg
Telephone: 0049- 40 - 227 59 208

info@decode-online.de

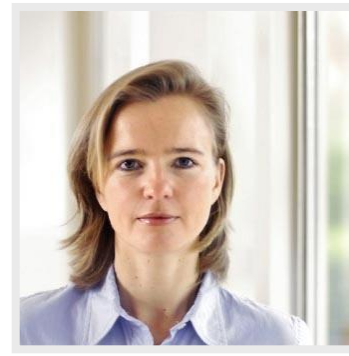
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