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6 Facial behavior

Abstract: We provide an overview of the current state-of-the-art regarding research on facial behavior from what we hope is a well-balanced historical perspective. Based on a critical discussion of the main theoretical views of nonverbal facial activity (i.e., affect program theory, appraisal theory, dimensional theory, behavioral ecology), we focus on some key issues regarding the cohesion of emotion and expression, including the issue of "genuine smiles." We argue that some of the challenges faced by the field are a consequence of these theoretical positions, their assumptions, and we discuss how they have generated and shaped research. A clear distinction of encoding and decoding processes may prove beneficial to identify specific problems – for example the use of posed expressions in facial expression research, or the impact of the psychological situation on the perceiver. We argue that knowledge of the functions of facial activity may be central to understanding what facial activity is truly about; this includes a serious consideration of social context at all stages of encoding and decoding. The chapter concludes with a brief overview of recent technical advances and challenges highlighted by the new field of "affective computing" concerned with facial activity.

Keywords: Facial behavior, nonverbal behavior, affect program theory, appraisal theory, dimensional theory, behavioral ecology, social context, affective computing

1 Facial expression and emotion

It is not surprising that a word signifying a place, or point, where people or bodies meet is *interface* – literally that which is between faces. The underlying notion is basically that the face is the portal to identity and soul (Kappas 1997). Expressions such as "losing face" (*Gesichtsverlust* in German) or "facing something" (*faire face* in French) indicate that there is more to face than meets the eye. Much of the cortex of the brain is visual and there seem to be several locations that have sensitivity to faces (Kanwisher, McDermott, and Chun 1997). Infants are drawn to face-like visual arrays basically from birth, and they react with facial mimicry only hours thereafter (Olk and Kappas 2011).

Nonverbal communication is a multimodal process embedded in intra- and interpersonal networks. Yet, despite the multi-modality, there is not only visual primacy, but within visual information the face is said to play a special role and, thus, it is not surprising that there is more research regarding faces and facial expression than other nonverbal channels, and it is not unusual that a systems overview, like in the present volume, will start with the face.

It is impossible to interpret the current state-of-the-art regarding research on facial behavior without a (modest) historical perspective. While the importance of the face for nonverbal behavior is evident to the scientist and layperson alike, there are some specific key theories, studies, and methodologies that have shaped not only much research on nonverbal behavior in the last century, but that still project into the future, for example in the guise of *why* and *how* facial activity plays such an important role in current efforts to have machines "understand" internal states, to assist mediated communication in the coming decades, or in efforts related to the detection of deception.

Thus, we decided to provide a historical and theoretical backbone in this chapter to provide a critical framework that asks questions as it informs, reaches out to many disciplines, and tries to provide a narrative that transcends the evershifting tug-of-war between those who emphasize biological constraints and those who focus on cultural meaning and differences. We will propose that (1) facial behavior should always be understood at multiple levels that include not only intra-personal, but inter-personal processes, even if someone is physically alone. Furthermore, (2) because facial behavior is best understood as an intricate element of nested systems that have self- and other-regulatory functions, it is at time difficult to separate concepts such as "expression" or "communication" from "regulation." Thus, the message we convey here is complex and might not always satisfy all readers. Despite our preference for the simplicity suggested by Occam's Razor, we feel that some stories lose if they are oversimplified. Occasionally, summaries regarding the state-of-the-art in research on facial nonverbal behavior appear to us too reduced. So it is perhaps best to start with the simple and uncontroversial statement that *faces are important*.

1.1 Importance of faces

It is quite common for articles, chapters, or books on face perception, or on nonverbal behavior involving facial activity, to emphasize just how important faces are (Schweinberger and Burton 2011). Faces may carry much information regarding gender and age, ethnic background, health, and social status. We identify individuals typically based on their faces – hence we have pictures of our faces in our passports and not of our feet – and we believe that faces betray the character of a person, as well as their current affective state and intentions. The belief in the importance of faces is likely shared universally and in art and ritual much effort may be exerted in different cultures and historical periods to capture the facial likeness of a person in a painting, or sculpture, or in contrast to hide as much as possible of identity or affective state as not to distract the viewer. It is most likely no coincidence that the currently most popular Internet community was called *Facebook* and the *profile picture* in most cases consists of an image of a face created and curated by the user in more-or-less conscious efforts to present oneself in a desired way. Current consumer cameras frequently possess programs optimized for portrait photography, increasingly even for specific expressions – such as smile detectors. All this apparently underscores the importance of faces and facial expressions.

1.2 Are faces special?

The discussion whether faces are *special* (Kappas 1997) is often anchored in particular findings or phenomena. For example, the groundbreaking research of Meltzoff and Moore (1977) demonstrated that infants imitate facial gestures literally hours after birth. As far as we know, this is not true for gestures or vocalizations. Furthermore, it is known that face-like configurations attract visual attention early on in life. In addition, there are neurological phenomena that seem to be specifically associated to perceiving faces (Young 2011); *Prosopagnosia* is a disorder that is associated with a selective deficit in distinguishing faces. In the meanwhile, with recently developed techniques for measuring activity in the living brain, an area in the fusiform gyrus of the human cortex has been identified that appears to be selectively activated when looking at faces. Nancy Kanwisher has coined the term fusiform face area (FFA; Kanwisher, McDermott, and Chun 1997) to refer to this region. Does this all add up to faces being not only important but *special*?

Each of the empirical findings mentioned can be qualified. Yes – infants imitate facial gestures – however, typically, these do not relate to what we think of as emotional gestures – such as opening the mouth, or sticking out the tongue. Yes, infants seem to be particularly attentive to faces, but this relates to specific distributions of cues in bounded objects – it is possible to create artificial stimuli that follow these rules and that are more attractive than face-like stimuli (Turati 2004). As regards the neuroscience findings – these are currently most discussed. There are several controversies, or at least exchanges. For example, there are also areas in the brain that react to man-made objects – this would argue against the necessity that faces are so special that they might come "prewired" for facial patterns. Also, FFA is activated when visual experts distinguish objects of their expertise, such as birds or cars (Gauthier et al. 2000). Additionally, Isabelle Gauthier has developed artificial objects, so-called *Greebles*, that have a similar complexity to faces and she and her colleagues could demonstrate that once people have learned to distinguish them, the FFA will be activated in this context (e.g., Gaulthier and Tarr 1997). Lastly, research by Haxby and colleagues suggests that the distinction of faces and other objects can best be understood by distributed and overlapping activity in different brain areas (Haxby and Gobbini 2011), as can be houses and other natural and man made objects.

In summary, present research cannot answer clearly whether FFA activation is a product of being prewired for a particular pattern at birth or whether any pattern of particular complexity with particular constraints is likely to achieve maximum activation in that location due to the brain's network architecture. We have almost limitless data from different disciplines that faces – and facial expressions – are important, both with regard to popular belief and folk theories, and with regard to the role faces and facial expressions play in person perception and in human interaction. This is evident. We do not need to take recourse in neuroscience to justify or bolster the argument of importance– present findings are consistent with the notion that faces and facial expressions *are* important and current research is informative about *how* the processing of nonverbal behavior interacts with other processes. But neuroscience is neither necessary, nor conducive, for fundamental arguments regarding the importance of faces for example. Neither is research outside of neuroscience soft, vague, or less scientific. The question whether facial expressions are *special* does not seem to be particularly useful, beyond the acceptance of importance.

2 Brief historical and conceptual overview

2.1 Charles Darwin

While there has been interest in facial nonverbal behavior before Darwin, often from the arts and philosophy (e.g., Montagu 1994 on Le Brun), the most fruitful starting point for any narrative on facial behavior is the publication of Charles Darwin's *The Expression of the Emotions in Man and Animals* (1872). In this book Darwin translates his comparative approach from structural/morphological comparisons of shapes and features of animals and plants to behavioral comparisons of humans and animals. It was very important for Darwin to demonstrate that emotional expressions were not unique in humans but instead had clear precursors in humans' ancestral past. The key argument here was that the specific shapes or patterns of expressions were typically neither arbitrary nor conventional, but instead relate to some primordial function that was not initially communicative but served a particular purpose, such as opening the eyes wide in situations where unexpected things happened (=surprise) to allow more visual information to be processed (see Shariff and Tracy 2011). It is known that Darwin was specifically motivated to counter religious arguments (e.g., by Bell) regarding how distinctive emotional expressions were to humans as opposed to animals (see Kappas 2003) – because of this strategic intention, much of the narrative of the book is dedicated to analyses and speculations of the original purposes of specific expressions in humans and animals. The usefulness and adaptive advantage of having a complex and fast messaging system, something that today would seem to be a typical Darwinian argument, played hardly any role in Darwin's original statements (see also Barrett 2011).

The methodological innovation of *Expressions* is stunning – it was one of the first to use photography for scientific purposes and contained posed photographs, candid photographs, wood engravings, often based on photos of adults, children, and animals. Iconic are the photographs of the electrical stimulation experiments by Duchenne de Boulogne that Darwin included to demonstrate how particular emotional expressions were the sum of the activation of specific facial muscles (see Prodger 2009; Smith 2009). There was also a cross-cultural component to the empirical methodology, as Darwin developed a questionnaire he then sent to people who lived in faraway countries. Darwin skillfully combined all of these different aspects, together with systematic observation and anecdotes, to weave a tale of how emotional expressions came about that caused great interest at the time (Cornelius 1996).

Charles Darwin was quite aware that there were strong cultural influences on expressive behavior, but because the intent of the book was to demonstrate evolutionary continuity, regulatory aspects, particularly as a function of learned "cultured behavior," were relatively deemphasized. This led in consequence to a simplification of the message in secondary and tertiary accounts and summaries, namely that Darwin supposedly focused on a small number of universal emotions and that their communication is of adaptive value. In reality, Darwin dealt with a *large* number of *mental states*, of which emotions are only a sub-group. For example, he discussed love and devotion, or meditation and determination. As Fridlund (1994) and Barrett (2011) point out, there are alternative ways to interpret Darwin's views on how socio-cultural influences impact facial expressions and their interpretation.

Darwin also discussed what later was referred to as the *Facial Feedback Hypothesis* by remarking that minimizing an expression would also diminish the associated feeling or that, vice versa, amplifying an emotional expression would lead to an amplification of the feeling. This is particularly relevant in the current renaissance of embodiment of emotional, motivational, and cognitive processes. Typically, the origin of the facial feedback theory is attributed to James who, later, proposed that bodily feedback, including facial actions, would impact or determine the subjective experience of emotion.

Initially, there was much interest in Darwin's book. However, in the succeeding decades, the "dark period" (Cornelius 1996), cultural differences were seen as much more pronounced than Darwin had suggested (see also Barrett 2011). In parallel, there was a general *Zeitgeist* that moved away from the analysis of internal states, such as emotions, as explanatory forces – particularly in the guise of behaviorism. While Darwin's theory of evolution was a major long term success, the *Expression of the Emotions* became one of the less important tomes in Darwin's impressive canon of work.

2.2 Paul Ekman: Neurocultural theory

It is the success of the work of Paul Ekman and his associates that has revived the interest in Darwin a century later. Ekman has arguably also shaped and channeled how we think about emotion, nonverbal behavior, and Darwin's contribution. In 1969 three key papers were published that together had a major impact for the field of emotion research and specifically on research on facial behavior. The first was an article published in *Science* (Ekman, Sorenson, and Friesen 1969) describing a study in which photographs of Americans were shown to participants in several countries, including Japan and Brazil, but also to members of the Fore tribe in New Guinea which had before this encounter almost no contact to the outside. Ekman and his colleagues showed their subjects photographic representations preselected to depict six emotional states. Ekman et al. reported that all of them were well recognized – following the predictions based on Tomkins' theory and Darwin's book (see Russell 1994 for a critique; also Ekman 1994).

The other two publications (Ekman and Friesen, 1969a, 1969b) dealt with different categories of nonverbal behavior and laid the groundwork for the concept of expression regulation and the display rule concept. Presently, this is known as the neurocultural theory, which assumes that there is a fixed link between a small number of basic emotions and various other components, including patterned physiological activation (Ekman and Cordaro 2011). Key, however, to what is regarded as basic emotions are the prototypical expressive patterns – specifically facial expressive patterns. The idea of the neuro-cultural theory is, in a nutshell, that if there was no motivation to regulate, for example due to cultural display rules, every human being would show the same expression for each of the basic emotions if it had been aroused by a biologically hard-wired or culturally learned elicitor. However, due to socialization different cultures, and also within cultures smaller social structures, would shape what is appropriate to show what, when, and to whom. In other words, the neuro-cultural theory has two components – the spontaneous expression of emotion and the regulation of expression that is a secondary process. This view can be illustrated most evidently on the basis of "felt" and "false" smiles. According to Ekman and colleagues (Ekman and Friesen 1982; Ekman, Friesen, and O'Sullivan 1988), a distinction should be made between smiles that occur spontaneously in conjunction with a positive affect and those that are voluntarily put on the face to hide or mask a negative emotion. In honor of the early work of Duchenne de Boulogne, the "Duchenne smile" has been proposed as a true indicator of enjoyment (Frank and Ekman 1993) that cannot be faked due to additional muscle activation around the eyes (i.e., orbicularis oculi muscle) which is difficult to control voluntarily (Ekman, Roper, and Hager 1980). Past studies have found that Duchenne smiles indeed tend to occur under circumstances of spontaneously experienced positive affect (e.g., Ekman, Davidson, and Friesen 1990; Ekman et al. 1988). However, there is also growing evidence which questions this clear cut distinction between spontaneous and voluntary expressions by showing that Duchenne smiles can be posed similarly as any other type of smile (see Krumhuber and Manstead 2009; Schmidt, Bhattacharya, and Denlinger 2009). Similarly, smiles can be observed that involve only the lower part of the face and not the wrinkles at the eyes, despite the fact that the expresser is concurrently happy or amused as indicated by self-report. Thus, the term "felt smile" should not be used synonymously with a morphological description, such as "Duchenne smile". It is the two-factor model exemplified by Ekman's neuro-cultural theory that has led many researchers to study facial behavior by confronting participants with emotion-eliciting stimuli or situations in a condition of social isolation to demonstrate the link between subjective experience and facial behavior. We later review the empirical findings from the point of view of different perspectives. However, it is important here to emphasize that the belief in a clear separation of spontaneous and regulatory forces is the cause of the standard social isolation paradigm.

The impact of Paul Ekman was enormous also because of methodological developments, such as the development of the anatomy based Facial Action Coding System (FACS), together with Wallace Friesen (1978). One of the strengths of this system is that it does not impose meaning categories. This is necessary for comparative studies that follow from the Darwinian framework. However, a discussion of FACS and related methods is best found elsewhere, for example in Harrigan, Rosenthal, and Scherer (2008). Many attempts to automatically measure facial activity by computer are influenced by these developments and provide FACS codes as output (e.g., Bartlett and Whitehill 2011), while new standards for data transmission and facial synthesis, such as the recent audiovisual data format MPEG 4, are also strongly influenced by FACS (Pandzic and Forchheimer 2002).

A final consequence of the theoretical frame of reference of a clear separation of genuine and controlled expressions concerns the notion of leakage via "micro-expressions" which is relevant for the study of deception (see Vrij, Granhag, and Porter 2010). Indeed, this has become the most active part of Ekman's research in the last decade prior to the publication of this handbook and has even entered pop culture in block-buster crime shows such as *CSI* (Levenson and Ekman 2006) and even a serialized television show *Lie to Me* that is based on a fictitious crime fighter who is using nonverbal behavior analysis for the detection of deception. Thus, the popularity of these methods and this framework has not only influenced scientists, but laypeople alike (but see Levine, Serota, and Shulman 2010).

2.3 Alan Fridlund: Behavioral ecology

The neuro-cultural theory and its variants were seriously challenged by Alan Fridlund in the 1990s. In a key experiment (Fridlund 1991) he demonstrated that implicit sociality affects facial actions, but not subjective experience. In other words, implicit or explicit awareness of others is sufficient to moderate the relationship between expression and subjective experience of emotion even if people are physically alone.

Fridlund proposed a different interpretation of Darwin's position on facial actions and argued that a Behavioral Ecology View (BEV) better explains facial nonverbal behavior – in this model, what is shown depends *exclusively* on social motives. A thorough analysis (also Fridlund 1994) suggests empirical support for this view both in animal and human research. A series of relevant studies in this respect were, for example, reported by Kraut and Johnston (1979). In one of these Kraut and Johnston demonstrated that smiles shown when bowling were not contingent with the actual moment of scoring or the success of the throw, but mostly with looking at their friends. This is when smiles had a social function and not associated with the actual emotion eliciting stimulus. Considering the BEV has a dramatic consequence for the interpretation of the meaning of facial nonverbal behavior. According to Fridlund, there is no relationship to emotion – in fact, emotion might not be a useful construct in this context at all (1994). It is important to clarify that both Fridlund and Ekman are Darwinian in their approach – both argue that facial nonverbal behavior has evolved and is functional in the here-and-now, but they differ with regard to the *meaning* of facial behavior. Implications of these theoretical views will be further explained below in the discussion of the relationship between emotion and expression.

Subsequently, Hess, Banse, and Kappas (1995) could demonstrate that Fridlund's view might have been a bit too extreme – they replicated the basic finding of Fridlund (1991), but by using amusing material of different intensity, they could show that smiling behavior was a function of social context *and* of intensity of the emotional stimulus. Furthermore, they could demonstrate that the Fridlund-effect worked only with friends, but not with strangers. In the meanwhile, there have been further replications (e.g., Jakobs, Manstead, and Fischer 1999a, 1999b, 2001). At present, neither the neuro-cultural theory and its variants, nor behavioral ecology sensu Fridlund, can account for these findings. There is need for further theoretical development.

3 Facial expression and emotion

3.1 Issues regarding the cohesion of emotion and expression

One of the key interests in facial activity is the potential diagnostic value for an emotional state. Hence, the following sections will focus on how expression and emotion relate to each other. While this sounds like an easy enough question to answer (is it or is it not), it starts to get complicated when one considers the issue of how emotion is specifically defined. In most current emotion theories, expressive behavior is not a consequence of emotion, but a component of emotion, together with other components, such as peripheral or central physiological activation, subjective experience, and action tendencies or changes in action readiness.

Researchers investigating how these components relate to each other study emotions based on their theoretical framework. Consequently, someone who comes from a background influenced by Ekman's work is likely to study only specific discrete emotions, so for example, jealousy or hate will not figure among these, because they do not appear to have universal expressions. A different important school of thought in current emotion research relates to appraisal theory. Starting from Darwin, via Craig Smith and Klaus Scherer, there are notions that specific evaluation processes are associated with specific expressions – for example blocking an obstacle might cause a frown. Research in this tradition has tested the question of emotion expression cohesion differently and will thus be discussed separately. A third important tradition conceives of emotions as entities associated with a two- or three-dimensional space, such as valence, arousal, and dominance/power. To complete the picture, we will also present relevant research embedded in the BEV.

3.2 Affect program theory

Current research on facial activity owes much to the work of Silvan Tomkins in the 1960s. Although most of the details of his theory have lost importance for present theories, the notion of affect programs itself is still influential. Both Ekman (e.g., 1992; also Ekman and Cordaro 2011) and Izard (e.g., 1997) propose that a core emotional repertoire exists, formed of a small number of fundamental emotions – for example, happiness, sadness, fear, disgust, anger, contempt, and surprise (Ekman 1982, 1984). Based on the notion of the affect program, each of these emotions is thought to be innate, categorically distinct, and characterized by specific physiological, expressive, and subjective responses (Ekman 1999).

For every fundamental emotion, Ekman assumes the existence of neuromotor affect programs which produce a fixed pattern of facial responses in response to the appropriate eliciting events (Ekman 1972). These emotion-specific facial patterns are prototypical and universal, each consisting of characteristic configurations of facial behavior as described in the Facial Action Coding System (Ekman and Friesen 1978; Ekman, Friesen, and Hager 2002). Thus, they occur in a consistent manner across different cultures and are reliably recognized as corresponding to one of the basic emotions.

Much of the empirical support for coherence between emotion and facial expression has come from recognition paradigms, thereby requiring participants to categorize pre-selected photographs of posed expressions (see Russell 1994). Thus, the results are limited in what they can reveal about the expression of emotion. Some evidence for the occurrence of individual facial components that characterize basic emotions has been provided by encoding studies, but they have not been able to support more restrictive predictions concerning coherent or prototypical patterns of facial actions (Carroll and Russell 1997; Fernández-Dols et al. 1997; Krumhuber and Scherer 2011; Scherer and Ellgring 2007). Even in the most optimistic studies (e.g., Ekman, Friesen, and Ancoli 1980; Ekman and Rosenberg 1994) the pattern of association between emotional experiences and behavioral responses was rather moderate, with correlations rarely higher than $r = 0.50$ (see Mauss et al. 2005). In other words, people often experience and report different feelings than what their expressions supposedly show.

The idea of a few core emotions and facial prototypes can seem counterintuitive, neglecting the large variability of emotional states (Ellsworth 1991; Smith and Scott 1997). In light of this, Ekman (1999) has, more recently, argued for the concept of *emotion families* which consist of several related emotions that share certain characteristics of expression, physiology, or antecedent events. To use happiness as an example, there is, according to this view, not just one "happy" emotion, but a number of positive emotions such as amusement, pleasure, satisfaction, and contentment which all have a particular type of smile in common, but are distinctive states (Ekman 1989). Interestingly, Ekman (1992) also acknowledges the existence of certain emotions which occur devoid of a universal facial signal, but may be characterized instead by a specific vocal expression or brain activation state. This view is shared by Izard (e.g., 1997) who similarly assumes the existence of emotions such as embarrassment, shyness, and guilt which are not associated with a specific expression (1997: 60). Up to now, it has not been entirely clear what constitutes an emotion family and distinguishes one from another. As variants for a given emotion often share certain patterns with another emotion (e.g., eyebrow raise in surprise, fear, and sadness), many facial actions may be common to multiple expressions (Smith and Scott 1997). Russell and Fernández-Dols (1997, see also Fridlund and Russell 2006), critics of the approach by Ekman, Izard and their mentor Tomkins, subsume this and similar theories under the term *Facial Expression Program*. Reisenzein et al. (2006) use the term *Affect Program Theory* (APT).

None of the proponents of APT argue for an indiscriminate automatism of facial expressions. That is, no individual will *always* smile when feeling happy or amused. As reviewed above, according to Ekman and Friesen (1969b) emotional expressions are modulated by culturally determined *display rules* regarding the appropriateness of certain expressions. Display rules are learned early in childhood and govern who can show what expression and at what time (see Matsumoto 2006). They can have the effect of exaggerating, minimizing, masking, or qualifying a universal expression of emotion depending on the social circumstance, and therefore interfere with the facial affect program. Early evidence was provided in a study by Friesen (1972) in which American and Japanese participants viewed highly stressful films. Whereas the Americans showed expressions of negative emotions (i.e., disgust, sadness), the Japanese participants were supposedly more likely to mask them with a smile in the presence of an experimenter (but see Fridlund 1994). The concept of display rules has been widely accepted within the framework of neuro-cultural theory and other variants of APTs, with research focusing on cultural differences in display rules (Matsumoto 1990) and inventories aimed at the assessment of display rule knowledge (e.g., Matsumoto et al. 2005). Such reasoning is not problematic in itself if display rule knowledge could be used to predict what expression should be shown in which situation (see Kappas 2009). Unfortunately, there is no consistent theory of display rules that would allow for a specific expression to be predicted as well as the types of contexts that elicit the modulation of facial displays (Kappas 2002, 2003; Parkinson 2005). In this sense, it seems to be the case that the notion of display rules would be used by several authors to justify negative empirical findings regarding predicted concordance of internal state and expressive behavior. Such an approach appears to circumvent the actual empirical investigation of the cause-effect relationship between emotions and expressions, thereby preventing an examination of the predictions by APT (Kappas 1996, 1999).

In order to demonstrate coherence between internal state and expression, the impact of display rules would need to be controlled or minimized. In doing so, the expression should be driven only by the emotion. Introducing such control should be possible if participants are studied alone, or if they are unaware of being observed (Kappas 2002). In other words, in social isolation the predicted cohesion between emotion and expressions should be strong. However, evidence from studies with participants whose facial expressions occurred in isolation does not entirely support this prediction (see Fernández-Dols et al. 1997; Fridlund 1991). Moreover, individual differences such as self-monitoring have an important impact on whether facial expressions are revealed or controlled (Friedman and Miller-Herringer 1991). The match between self-reported emotional state and predicted facial expressions therefore seems to be far from perfect. In consequence, it is problematic to use prototypical expressions as diagnostic for the presence of specific subjective experience, as the cohesion is demonstrably low.

3.3 Appraisal theories

Rather than assuming a limited set of basic emotions, appraisal theories conceive of emotions as dynamically emerging response patterns resulting from a series of evaluation appraisals (Ellsworth 1991; Roseman 1991; Scherer 1984, 2001, 2009). In this sense, emotions are not driven by neuromotor programs, but elicited and differentiated by the way an individual evaluates (or appraises) the environment. These appraisal checks or information processing steps concern a number of criteria such as the relevance and implication of an event for a person's goals and needs, the required coping potential, and the normative significance of the event (Scherer 1984, see also Scherer, Schorr, and Johnstone 2001). Depending on the result of each appraisal check, different emotions are thought to be elicited. Proponents of appraisal theory further contend that appraisals trigger changes in several organismic subsystems (i.e., cognition, physiology, motor expression, subjective feeling; Roseman and Smith 2001; Scherer 2001), with evaluation outcomes in particular subsystems affecting one another. The emotion process is therefore considered to be a fluctuating pattern of change in various interfacing central and peripheral systems that become temporarily synchronized (Scherer 2009). Appraisal theories do not exclude the possibility of a number of discrete emotions such as joy, anger, or fear that are *modal* outcomes of frequently occurring patterns of appraisals (Scherer 1984). However, as opposed to basic emotion theory, appraisal theory alternatively posits an infinite number of emotions as well as large individual variability in emotional states and expressions (Scherer 2009).

Following this approach, facial expressions are linked with appraisal dimensions rather than specific emotions, and are determined by appraisal check outcomes. For instance, frowning as the emotional appraisal of goal obstruction occurs when perceiving an obstacle that hinders us reaching a goal. Given that more than one negative emotion can follow the perception of an obstacle, several patterns of facial action can call for the display of the frown (Kappas 2003). This allows for the possibility that the same appraisals, although in various combinations, are part of multiple emotions. Notably, the facial movement overlap for different emotions can indicate shared appraisal profiles (Scherer and Ellgring 2007). Facial expressions are therefore similar to one another to the degree that they have comparable outcomes for appraisal dimensions. In contrast to APT, this suggests that there is no emotion specific situation which elicits anger or fear expressions, and that individual appraisals are the determining factors for facial responses (Aue, Flykt, and Scherer 2007). In this sense, an angry person perceiving an obstacle may frown as would a person who is fearful (see Ellsworth 1991). Existing evidence indicates that there may indeed be an association between certain facial expression movements and situational appraisals. For example, eyebrow raising was found to encode appraisals of novelty and unexpectedness (Kaiser and Wehrle 2001; Smith and Scott 1997). Furthermore, eyebrow frowning was related with appraisals of goal discrepancy and anticipated effort (e.g., Kappas and Pecchinenda 1999; Smith and Scott 1997), whereas raising of the lip corners was observed to correspond to appraisals of subjective pleasantness (e.g., Aue and Scherer 2008).

While there is nothing *a priori* wrong with the assumption that certain appraisal-driven facial actions may occur for different emotions, the search for componential cohesion is complicated by the fact that single muscle movements (e.g., frowning) can be driven by both different appraisals as well as other processes (concentration, visual requirements; Kappas 2009). The question here concerns the inversion of the predicted appraisal-expression link, i.e., whether a single expression is indicative of a specific appraisal (Kappas 2003). For example, the perception of an obstacle might lead to a frown. But, is it valid to use the presence of a frown to deduce that someone perceives an obstacle, or is simply engaged in effortful behavior? Moreover, Scherer and Ellgring (2007) recently suggested that frowning may also occur when experiencing an unfamiliar event (novelty appraisal). It is therefore impossible to infer appraisals and their alternative causes from these facial movements. Cacioppo, Tassinary, and Berntson (2000) refer to such facial actions and multiple determinants relationship as a *many-to-many* relation. Following this logic, specific changes in facial expressions cannot be reliably predicted on the basis of specific appraisal outcomes. Because some muscle movements are associated with several appraisals the diagnostic value of appraisal-specific facial actions consequently remains unclear (see Kappas 2003, 2009).

A fundamental difference between APT and appraisal views concerns the proposed nature in which facial expressions unfold over time. According to APT, facial actions triggered by a neuromotor commands simultaneously merge together exhibiting a prototypical pattern with overlapping apexes (Ekman 2003). This view differs from the general appraisal theories view in which facial movements are thought to occur with the outcome of the appraisal. Because appraisals occur in sequential fashion (Ellsworth 1991; Roseman and Smith 2001; Scherer 1999), each of the resulting facial responses is argued to accumulate over time, consisting of serial cumulative apexes with different contributing facial action sequences (see Figure 1; Scherer 2009; Scherer and Ellgring 2007). Apart from preliminary evidence for this sequence assumption (Krumhuber and Scherer 2011), the significance and fusion of partial expressions remain unknown. For example, do all appraisal-driven facial actions equally contribute in conveying a specific expression or are some actions more intense and longer lasting than others (Paleari, Grizard, and Lisetti 2007)? Do different sub-expressions merge over time and can this convergence be described as an additive process?

According to the appraisal view, there is not a single evaluation phase that instantaneously takes place. Instead, appraisals are thought to be constantly in flux with re-appraisals replacing initial appraisals (Scherer 2001). In this sense, evaluations are performed continuously to correct and update the organism's information about pertinent situations and events (Scherer 1999). If appraisals are recurrent processes, the following question emerges: What diagnostic value can be ascribed to individual facial actions? Given that appraisal-driven facial movements can be replaced by newer evaluation processes, they may simply contribute to a later evaluation stage and thus might not be meaningful on their own. In addition to questions concerning the temporal overlap of facial expressions, the significance

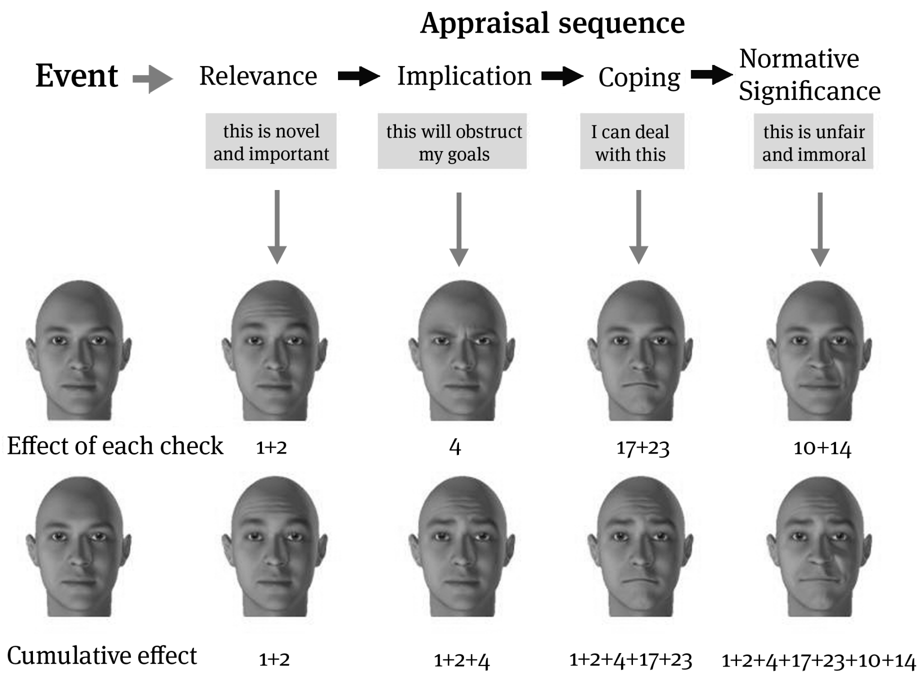

Figure 1: Illustration of the sequential nature of the micro process involved in the appearance of an emotional expression according to Scherer's Component Process Model (based on Scherer and Ellgring 2007). Numbers indicate FACS action units.

of individual elements of facial expressions as determined by appraisals remains an unresolved issue. Furthermore, it is doubtful that every evaluation process is in fact reflected in the face. As such, some appraisal processes may not lead to visible changes in the face and/or may be immediately replaced by newer evaluation appraisals and corresponding facial changes. Until now, there is no evidence that all appraisals are coupled to specific muscle reactions (see Kappas 2009).

In addition to these concerns, there is the problem that we often do not have conscious access to the appraisal process. In fact, appraisal theorists have argued that much of the appraisal process is automatic and occurs outside of conscious awareness (Leventhal and Scherer 1987; Scherer 2001; see also Kappas 2003, 2006). It is therefore difficult to prove whether a specific appraisal (for example that a person evaluates her coping potential as high) leads to a specific change in facial actions (tight lips) (see Scherer 2001). If facial movements are interpreted as signs of specific appraisals, there is the danger of being trapped in a circular argument as there is no independent criterion that would prove the existence of the underlying appraisals (Kappas 2009). Thus, independent of future findings, there are significant conceptual problems in using facial actions as diagnostic of underlying affective states to infer specific appraisals (Kappas 2003).

3.4 Dimensional views

Dimensional emotion theories view individual emotional states as localized within the space of a limited number of dimensions, typically either valence and arousal (2D), or with the addition of a third dimension called potency or dominance (3D; e.g., Bradley and Lang 1994; see Roseman and Smith 2001). On a conceptual level, dimensional views can therefore be interpreted, in a first approximation, as a mapping of higher-dimensional emotional states onto two or three underlying or "core" dimensions. The cost of this is a certain loss of information (see e.g., Zeng et al. 2009). However, the gain may be a clearer picture and comparatively reliable measures.

Compared to appraisal views, there are certain conceptual similarities with appraisal dimensions (e.g., "pleasantness", "coping potential") – however, the focus of the latter is more on the suggested processes and their components (see e.g., Scherer 2009), whereas dimensional views focus on how "single simple feelings," i.e., "Core Affect" (see e.g., Yik, Russell, and Steiger 2011) as such can be studied rather than the entirety of a broader spectrum of appraisal processes. Compared to APT, dimensional views argue that it is the "core" dimensions which are basic (see e.g., Yik et al. 2011) rather than a specific number of conceptually distinct emotion constructs like *fear* or *anger*. For example, Russell (e.g., 1997) suggests that valence and arousal are primary and automatically perceived dimensions whereas categories are only derived in a second stage as a function of the social context (see also Fernández-Dols and Carroll 1997; Kappas and Poliakova 2007). In other words, here is a claim that a large part of mood and emotion could be understood if the main dimensions (e.g., valence and arousal) can be well understood. And, importantly, because these two dimensions are postulated to be simpler, they should be easier to access and more reliable to measure. This fits well with the theme of cohesion we have been discussing earlier in this chapter.

From a measurement perspective that focuses on the face, a reduction to just two or three dimensions immediately has advantages because it eliminates the need to categorize any and all possible patterns of facial muscle activation (e.g., using FACS). In support of the notion that such a simplification may be possible, a very consistent finding in the literature across different views has been that joy/happiness (i.e., positive valence) clearly appears to be the single most accurately recognized emotional state judged from faces (well above 90% correct), whereas differentiated judgments of negative emotions perceived in faces have been considerably less accurate (Ekman and Friesen 1971; Russell and Fernández-Dols 1997; Scherer and Scherer 2011). Furthermore, one could look at participants' ability to report about their subjective experience. Here, dimensional views typically assume that participants can always access and express their momentary emotional state on the underlying dimensions (e.g., Yik et al. 2011), which may indeed be easier than a finer differentiation into, for example, basic emotion labels.

There is indeed much that can be said to be simpler about dimensional views than most of the competition, which clearly lends dimensional views a certain practical appeal. For example, instead of complex and time-consuming FACS-coding, a dimensional framework lends itself more easily to a measurement via facial electromyography, e.g., at the Zygomaticus Major (cheek) and Corrugator Supercilii (brow) sites. Simultaneously, there are a variety of measurement instruments available to obtain subjective experiences of valence and arousal, e.g., traditional Likert-type scales, the largely non-verbal "Self-Assessment Manikin" (Bradley and Lang 1994), or a continuous device like *FEELTRACE* (Cowie et al. 2000). However, it also has to be acknowledged that the simplification obtained by projecting a higher-dimensional space of discrete emotional states onto just two dimensions necessarily results in a loss of information where emotions like *fear* and *anger* can become indistinguishable (e.g., Zeng et al. 2009; Yik et al. 2011). Nevertheless, the critical question may be to see whether the reduction of complexity achieved by dimensional views can be translated into better cohesion between subjective experience and the face.

Regarding cohesion, dimensional views overall indeed appear to have found relatively reliable facial indicators for valence – whereas very few studies have been able to make a strong case for emotion specificity (Mauss and Robinson 2009; see also Reisenzein 2000, Reisenzein et al. 2006). More specifically, Cacioppo et al. (1986) suggested that activation of the Zygomaticus Major, which plays an important role in smiling by pulling the corners of the mouth to the side and up, and Corrugator Supercilii muscles, that pull together the eyebrows, is related to the valence and intensity of emotional states. Given this evidence, one would expect dimensional approaches to have a strong position whenever cohesion between subjective experience and facial behavior becomes relevant for applied purposes. The situation, however, appears to be more complicated.

In fact, the great majority of state-of-the-art vision-based practical efforts to automatically measure affect are concerned with detecting basic emotion categories (see Zeng et al. 2009). In this sense, the strength and general influence of the FACS is associated with a need of practitioners working with dimensional models to express their data also within the somewhat more familiar terms of basic emotions, action units, and their associated visible counterparts. An early example of how facial action units might thus be re-aligned into the pleasure-arousal space has been provided by Russell (1997; see Figure 2a). However, the applied potential of this approach may well exceed the task of a simple mapping as such, because dimensional models can also be applied as modeling functions on top of basic FACS units. This was shown beautifully, for example, by Grammer and Oberzaucher (2006; see Figure 2b).

But back to the question of cohesion: It has meanwhile become clear that Zygomaticus Major is active not only during positive but also during negative states (Kappas and Pecchinenda 1998; Larsen et al. 2003). This curvilinear relationship

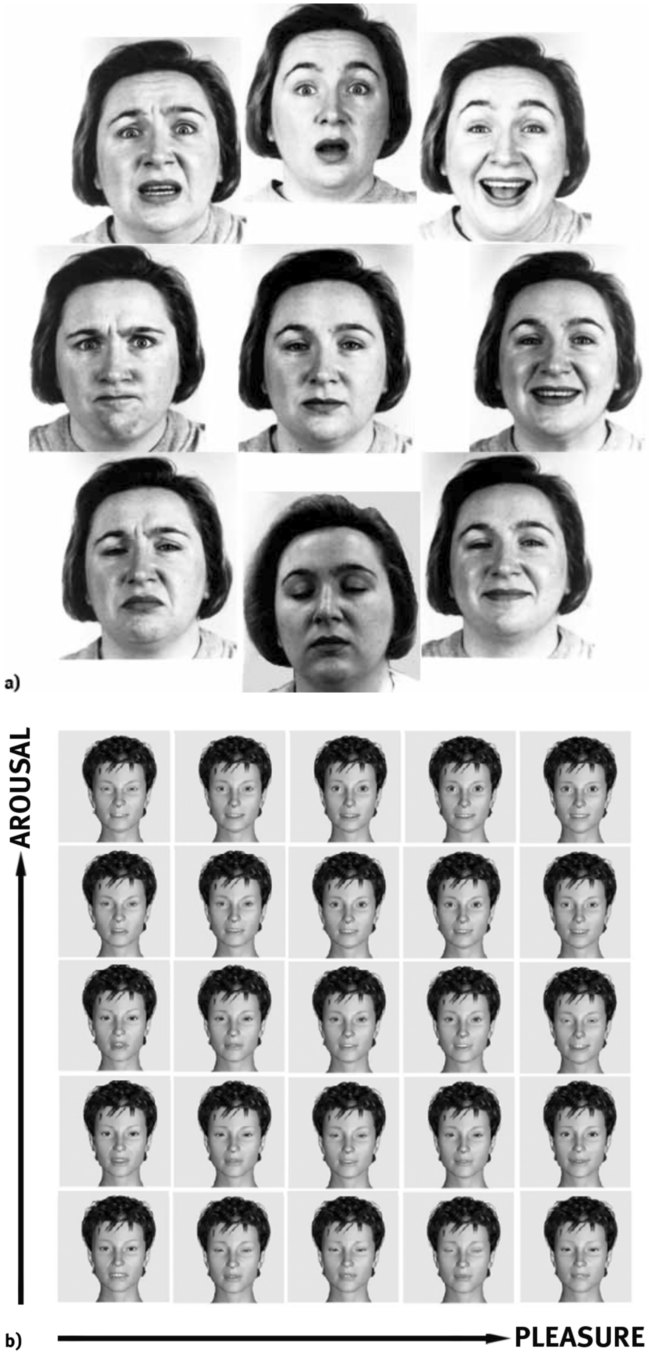

Figure 2: a) Eight facial expressions in the Pleasure-Arousal space of a 2D dimensional view (reproduced with permission from Russell 1997). **b)** The completely reconstructed pleasure and arousal space (reproduced with permission from Grammer and Oberzaucher 2006)

means that one cannot unconditionally interpret the activation of this muscle in a test subject as a positive emotional state. In principle, activation of Corrugator Supercilii muscles appears to be a better correlate of emotional valence than a smile. Furthermore, a relative relaxation of the Corrugator Supercilii muscles has been observed for positive emotional states (e.g., Kappas, Bherer, and Thériault 2000), which means that a linear relationship with subjective valence can be expected for this muscle site. However, does this clear linear relationship allow an unambiguous mapping of activity of the corrugator muscle to positive and negative emotional states (see e.g., Larsen et al. 2003)? Unfortunately, the problem in this case is that the Corrugator muscle is also activated by factors other than valence (e.g., visual stimuli and concentration, as discussed in the previous section on appraisal), and that it also plays an important role in communication and interaction, for example in accompanying or emphasizing elements of speech. This means that there is no simple or unproblematic mapping of muscle activation to emotional states, not even for the suggested "core" dimension of valence. On the other hand, it should nevertheless in principle be possible to identify configurations or patterns of muscle activation that may possess higher diagnostic value – at least if given a sufficient understanding of the context. In addition, dynamic characteristics of facial behavior (see e.g., Krumhuber and Kappas 2005, Schmidt et al. 2006) may be able to contribute substantially toward distinguishing social components of facial activity from activity that may show better cohesion with subjectively reported valence – and perhaps also other dimensions. More research is likewise needed to determine to what extent complex information about facial activity may be combined with other data, e.g., in situations where people produce speech or written texts that can be analyzed (e.g., Kappas et al. 2011).

3.5 Behavioral ecology

Originally, the BEV (e.g., Fridlund 1991, 1994) has to a large extent been a counterprogram to the overall more influential *Affect Program Theory* (APT). The contrast is perhaps most clear when focusing on the issue of cohesion between subjective experience of emotion and the face. APTs, in essence, hold that there should be an underlying perfect cohesion between emotion and the face if only the *noise* produced by culture, display rules, lying, etc. can eventually be fully accounted for with the right set of measures. In a pure BEV, there is no place and function for any kind of truthful transmission or "leakage" of emotion. Rather than something that is only added later via culture, core authors like Fridlund (e.g., 1994) consider deception as an inborn and omnipresent core constituent of facial behavior. To even speak of *emotional facial expressions* is, in this view, a misnomer (see Hess and Thibault 2009) because the face has not evolved to express emotions – rather, the purpose of the system is assumed to be entirely devoted toward communicating *social motives*, e.g., a readiness to play, to appease, or to attach oneself to another (depending on the context; see Fridlund 1994).

Not all authors who view themselves as belonging to the BEV reject the usefulness of emotion as a concept, and even Fridlund more recently seems willing to make concessions in this regard (see Fridlund and Russell 2006). However, a driving idea behind many of the studies from or related to this tradition is the assumption that *social context* or *social motivation* may be of greater importance for facial behavior than any potentially associated emotional states (see studies by Kraut & Johnston, 1979; Fernández-Dols & Ruiz-Belda 1995, 1997; Ruiz-Belda et al. 2003). As reviewed recently by Barrett and colleagues (Barrett et al. 2011), the often neglected importance of social context in perceiving emotion from the face has been clearly demonstrated by different studies and methods. Much of the increased sensitivity to the importance of the social context beyond the status of a nuisance variable in more recent studies may be due to research directly or indirectly inspired by behavioral ecology.

But what about cohesion between facial expression and social motivation – the construct that Fridlund and other representatives of BEV propose as causally related to facial behavior? Unfortunately, Fridlund is extremely vague about the psychological mechanisms that mediate social context (Kappas 2003). There is little empirical evidence for stronger cohesion between *social motivation* and facial behavior than between the latter and emotion. Attempts to combine *behavioral ecology* and *display rules* to explain emotion strongly suggest a need for integrative models (see Kappas 2002; Parkinson 2005; Parkinson et al. 2005). Almost certainly, neither the neuro-cultural model, nor other existing variants of APT can sufficiently explain the empirical data obtained by behavioral ecology (Kappas 1999). Conversely, studies from the BEV-context have clearly failed to eliminate the concept of emotion as one of the triggers of facial behavior (see Hess et al. 1995). Again, the verdict is not yet in. That both suspects have a part to play appears certain – yet precisely how this is orchestrated still remains a question in lack of definitive answers.

4 Facial communication and regulation

4.1 Framework

Early research on facial behavior, for example the questionnaires employed by Darwin, have confounded encoding and decoding processes. To know whether a particular expression occurs when someone is happy it is sufficient, in this view, to ask someone whether s/he has seen the expression. However, what if that person did not see it, but the expression was there? Hence, many researchers have stressed the importance of measuring independently the relationship of some internal state and its externalization on the one hand and the relationship of particular expressive features and the perception and attribution on the other (Kappas, Hess, and Scherer 1991). However, even then, communication is often seen as a sequential process that can be seen as independent modules. This is a useful research paradigm for some questions, but there might be a price to pay – namely that the dynamics of interaction – perhaps the key aspect of nonverbal behavior gets lost.

As we have outlined above, we know now that expressions often do not express emotional states (low correlation between subjective experience, physiological activation, and expression), impressions fail (we know little about decoding of "real" expressions due to the stereotypical material used in many studies, but if spontaneous material is used "recognition" drops drastically), and we know almost nothing about what impact expressions have or in a more general sense what expressions *do* in interaction to the sender and receiver (see Kappas and Descôteaux 2003).

We believe that it is useful to think of expressions as part of a system that regulates. It regulates the expressor and those around, perhaps even those who are only explicitly around. The different levels of regulation are closely linked at times difficult to disentangle (Kappas 2011a, 2011b). Much of this process is outside of awareness and automatic. One component is cultural rules, mediated via social learning. However, at the heart of this process lies a nested set of regulatory influences associated with biological systems that we share with our evolutionary ancestors.

4.2 Critical evaluation of decoding studies

4.2.1 Encoding and Decoding

To capture the complexity of the communication process the modified Brunswikian lens model by Scherer and his collaborators has proven particularly useful (e.g., Kappas, Hess, and Scherer 1991; Kappas 1997). The model allows for the distinct contemplation of cues on both the encoding and decoding side by identifying, on the one hand, states or social motives which are encoded by the sender, and on the other hand, those which are perceived and decoded by the observer. Different processes such as display rules or social intentions can modulate or mask the encoding of internal states in nonverbal behaviors reviewed in the previous section. Even if there were objective encoding cues, for example fear in the voice, face, or posture, it cannot be assumed that they are also perceived or decoded in a specific situation (Kappas 2009). Accordingly, cues from both the sender and receiver side may be linked, but can equally be restricted to one side.

Evidence for the different utilization of facial features information comes from a study by Hess and Kleck (1994) in which participants had to differentiate posed and spontaneous expressions of happiness and disgust. Although participants were able to accurately report the facial cues they employed in the task (e.g., gaze aversion), these cues were not valid discriminators of the posed and spontaneous expressions. Similar findings had previously been reported by Hess et al. (1989) in which parameters describing the temporal characteristics of posed and felt smiles were not correlated with the observers' ratings of the sender's happiness. The significance of facial cues therefore varies between sender and observer and thus cannot be assumed to be congruent.

Furthermore, the attribution process of perceivers may be grounded in idiosyncratic stereotypical knowledge of emotion expressions that lead to a biased perception of facial displays. These concern static (e.g., facial morphology) or dynamic features that are erroneously interpreted as a cue for a certain state or the intentional communication of the individual. For example, cultural and gender stereotypes have led to different interpretations of the same facial expression for anger and happiness (e.g., Hess, Blairy, and Kleck 1998, 2000). Also, particular facial configurations connoting physical attractiveness or maturity can influence the attribution process by suggesting social traits that resemble stereotypes (e.g., Langlois et al., 2000; Todorov et al. 2005). As such, the way facial behavior is judged can therefore depend less on the intent and actions of the sender, and more so on the biases and implicit theories of the perceiver. Unfortunately, there are only a few studies on the face which combine an explicit analysis of the encoding and decoding process (e.g., Hess and Kleck 1990, 1994; Hess et al. 1989).

4.2.2 The problem of using posed expressions for investigating the communicative function of expressive behavior

The complexity of the decoding process is commonly underestimated (see also Russell, Bachorowski, and Fernández-Dols 2003). In most studies the "recognition" of emotions is examined by using static, posed, and stereotypic expressions. These generally consist of still posed expressions (photographs) at or very near the peak of emotional display. Clearly, such stylized and static materials do not reflect the true form of facial expressions. In everyday communication we are confronted with complex expressions that move in space and time. Apart from the greater ecological validity in using moving expressions for research, facial dynamics on the whole play an important role in the decoding process (see Krumhuber and Kappas 2005; Krumhuber et al. 2007). The problems of idiosyncratic posed expressions have been evident at least since Feleky (1914). Hence, standardized sets of posed faces are often used, such as the *Pictures of Facial Affect* (Ekman and Friesen 1976), the *Japanese and Caucasian Facial Expressions of Emotion and Neutral Faces* (Matsumoto and Ekman 1988), the *Karolinska Directed Emotional Faces* (Lundqvist, Flykt, and Öhman 1998), the *Montreal Set of Facial Displays of Emotion* (Beaupré, Cheung, and Hess 2000), the *Radboud Faces Database* (Langner et al. 2010), the *Geneva Multimodal Emotion Portrayals* (Bänzinger and Scherer 2010), or the *Amsterdam Dynamic Facial Expression Set* (Van der Schalk et al. 2011).

Beyond these limitations, there is the additional and maybe greater underlying problem that posed (voluntary) and spontaneous (involuntary) expressions probably differ with respect to the innervation of the face (Damasio 1994; Gazzaniga and Smylie 1990; Rinn 1991; see also Kappas, Hess, and Scherer 1991). That is, voluntary and involuntary movements are enervated by different neural pathways. The presumed distinction is supported by double dissociation clinical reports. That is, there are patients who can show expressions on request, but are spontaneously inexpressive and vice versa (see Rinn 1991). Several facial muscles and regions differ in the degree to which they can be voluntarily activated. These differences become even clearer when dynamic movements are imitated compared to static expressions (Girard et al. 1996). Specifically, dynamic presentations have been shown to improve emotion recognition in brain damaged patients who are unable to identify expressions from static displays (Adolphs, Tranel, and Damasio 2003; Humphreys, Donnelly, and Riddoch 1993). Facial cues such as blushing, the presence of tears, or variation in gaze, all of which are likely associated with affect, are typically absent from all of these studies or standardized stimulus sets.

Therefore, faces in standardized photo sets may not show the emotional state as felt by the actor, but instead may be more depictive of a stereotype of said state. In most cases, the emotional state of the person is unknown. Although the particular target emotion is often detected in photos presented to participants in judgment studies, it may be more telling about the emotional portrayal of the actor (the emotion they want or should show) versus what the actor actually feels. The fact that some of these judgment studies reveal high agreement for specific, standardized expressions does not permit us to draw any conclusions with respect to the participants' ability to recognize what another person is actually feeling in a specific real world situation. This may be due to the fact that spontaneous emotional expressions are characterized by great variance in their appearance, as shown in studies from Landis (1924) to Fernández-Dols et al. (1997). Similar doubts apply to judgments studies with posed vocalization or postures (see Bachorowski 1999; Kappas et al., 1991).

4.2.3 The impact of the psychological situation on the perception of expressive behavior

Perhaps the biggest problem in numerous judgment studies lies in their use of limited facial primes; presenting faces without context. The (in)famous experiment by Lew Kuleschow powerfully demonstrates that the perceived meaning of an expression greatly depends on its specific context (Russell 1997; Wallbott 1988). Kuleschow, a Russian director, produced three silent films concluding with a close-up shot of the main actor. His expressionless face followed the depiction of a bowl of hot soup; a dead woman in a coffin; and a girl playing with a teddy bear. In all three cases, the same neutral expression was interpreted as demonstrating a different emotion (Kalkofen 2007). Although Kuleschow was not an experimental psychologist and the "experiment" is poorly documented – no copy of the films apparently survived – the paradox inspired several researchers to systematically examine the role of context in the perception of expressions (see Barrett, Mesquita, and Gendron, 2011; Carroll and Russell 1996; Fernández-Dols and Carroll 1997; Fernández-Dols, Carrera, and Russell 2002; Russell 1997; Wallbott 1988). From their findings it is clear that social context can play a major role in the perception of emotional expressions. Moreover, other contextual information such as body postures (e.g., Aviezer et al. 2008), voices (e.g., de Gelder and Vroomen 2000), and surrounding emotional faces (e.g., Masuda et al. 2008) have been found to influence which emotion is attributed to the corresponding facial expression. Given these types of findings, it is highly unlikely that our brain processes emotional states according to a fixed set of six or seven emotions and that we detect others' emotions via matching to these templates.

It is important that the critical remarks concerning the methodology used to examine the decoding of expressive behavior (regardless of modality) are not misunderstood. Expressive behavior is neither arbitrary nor purely a social construction. It may be more advantageous to look at certain expression patterns (of biological origins) in varied embedded social and cultural contexts. Most studies using static, posed, and context-free stimuli cannot then offer us any additional information. When we see a report on television about a demonstration in the Middle East as result of a terroristic act, do we really know how sad those crying and screaming people are? Can we accurately judge the success of a joke by looking at the faces of our friends?

4.2.4 The paradox of self-representation of our decoding skills and the actual skills

In general people do not have good (although higher than zero accuracy) estimates of their emotion detection skills (see Hall, Andrzejewski, and Yopchick 2009). Even the intensity of one's own expression and the detection by others are often misjudged (Barr and Kleck 1995; Holder and Hawkins 2007). One of the many interesting results in this context stems from the well-named contribution by Ekman and O'Sullivan (1980) "Who can catch a liar?" Ekman and O'Sullivan demonstrated that even professionals who "read" faces for a living, such as police officers, psychiatrists, or judges, failed to distinguish real from faked emotion. However, when asked before and after the task how the participants viewed their own skills, it became apparent that subjects overestimated their skills. Such tendency to overconfidence was also found by several subsequent studies on lie-detection skills (for an overview see Vrij, Granhag, and Porter 2010). In a meta-analysis of 206 studies, experts (i.e., law enforcement personnel, judges, psychiatrists, job interviewers, and auditors) did not perform significantly better than nonexperts, thereby replicating the findings by Ekman and O'Sullivan (1980). On average, people achieved a 54% truth-lie discrimination rate which is only slightly above chance performance of 50% (Bond and DePaulo 2006).

In light of these findings, how can it be that we believe that we are good in reading others' expressions when in fact we are not? Obviously, it is useful to have a certain sensitivity to the expression of others, but it is also useful to be able to strategically use the nonverbal messaging system to achieve certain goals. If each of these attempts were transparent, social intercourse would break down. Such arguments have been made in the context of lies in general, but they hold also with regard to nonverbal behaviors specifically and here facial actions. If every mother in law would understand that the tie was not a welcome gift (to use the stereotypical example of expression moderation), then different strategies would have to be used. This is all not very new. However, just as the theoretical schools (affect theory, appraisal, dimensional, behavioral ecology) shape experiments and paradigms, so does the naïve view that affects researchers as well. Just because stereotypical expressions are well recognized and this resonates with our subjective belief that overall, we are good in reading others, we should not be deceived. For example, meta-analyses have revealed that many nonverbal cues that are studied by researchers in deception studies show no relationship with deception at all (DePaulo et al. 2003). Moreover, studies using spontaneous expressions demonstrate much lower "recognition" rates. If we want to understand how much someone who has deficits in recognizing affect is handicapped, we need to know how good the "normal" person is, with candid stimuli that come from real situations.

4.3 Interpersonal emotion regulation

As outlined above, two-factor models that conceptually separate spontaneous from regulated expressions led to experimental paradigms that tried to isolate the social regulation from the "genuine" expression by isolating the subjects while they were being confronted with emotion-eliciting stimuli. In consequence, the social functions and effects of expressions have been completely pushed outside of the picture. In the attempt to separate encoding and decoding in different types of studies possibly much got lost regarding what expressions actually do (Kappas and Descôteaux 2003). At an intra-individual level, there is now convincing evidence that there are (facial) feedback processes that help to up- or down-regulate affective states – despite the fact that apparently sometimes the attempt to modulate expressive activity leads to the opposite effect (Kappas 2011b). At the interindividual level there are multiple processes that go beyond communicating the present state (APT) or communicating a present social motivation (BEV). There are complex patterns of contingent reactions, imitation, and synchrony that constantly modulate the interpersonal relationship and that play a critical part in empathy.

Understanding who does what and when on the face must be interpreted in social contexts – this is clearly one of the biggest lacunae in current nonverbal research. There is a long tradition of research on nonverbal behavior in interaction ranging from interpersonal accommodation (see Burgoon, Stern, and Dillman, 1994) to more recent interest in the chameleon effect (Chartrand and Bargh, 1999; see Chapter 18, Lakin, this volume). Research focusing on facial behavior, due to the theoretical forebears has been somewhat agnostic regarding activity in interaction. Of course, there are also pragmatic difficulties, but these are slowly becoming less of an issue. For example, the advent of synthetic agents whose behavior can be manipulated in real time opens new avenues that were not available when analyses had to remain at a descriptive level, or rely on conscious manipulation of expressions by confederates. More research is needed.

5 Practical applications of facial behavior research and their limits

Facial behavior is of great interest for a number of applied questions, e.g., traditionally in the clinical context (Kappas and Descôteaux 2003; Philippot et al. 2003), and in the last decade also in connection with fighting terrorism or other forensic issues (Ekman 2001; Kluger and Masters 2006; Vrij and Mann 2005). Connected to both fields as well as even everyday applications is the new field of "affective computing" (e.g., Kappas 2011c; Picard 1997; Picard et al. 2004) that has been vigorously moving towards real-time, real-life automatic monitoring of emotions made possible by new mobile devices (see e.g., Picard 2010). For the purposes of obtaining a technical readout of facial activity, such devices can be as simple as any commonplace inbuilt webcam connected to the internet (e.g., www.affectiva.com/affdex/). For clinical purposes, there are, for example, toolkits being developed to help people with an autism spectrum disorder to understand and respond to facial affect in ongoing social interactions (e.g., Madsen et al. 2009).

There is certainly reason to be enthusiastic about the new avenues of research being opened by mobile or everyday recording devices and sophisticated algorithms that may even be able to extract non-muscular activity from the face, e.g., heart rate variability (see Poh et al. 2011). However, while there are some truly amazing technical and algorithmic advances in the field of affective computing, such technological improvements alone cannot bridge the chasms that still remain on the side of psychological theory.

As we have discussed earlier in this chapter, perhaps the most critical question here is the issue of only moderate cohesion (see also Kappas 2010), even in the case of highly controlled laboratory studies. Without measures and algorithms that can parse not just the surface level of the image and how it relates to the muscles –

but also the complex level of the social and individual psychological context that gives meaning to the muscles – the challenge still remains to connect this data to systematic and accurate psychological meaning. Clearly, reliable real-time FACS coding is not a sufficient answer because cohesion can be so low (see e.g., Reisenzein 2000; Reisenzein et al. 2006). The temptation is there, obviously, to go ahead and develop products and applications based on the most optimistic assumptions of cohesion – up to the point where one would consider the entire problem to be solved once the technical problem is solved. However, to work on the basis of disproven assumptions here could be very costly indeed – since it could easily lead to mistakes, bias, and systematic error in interpreting facial muscle activity as expressing an emotion when it might rather communicate something else entirely in a specific social situation to which the system is agnostic. This criticism also applies for other applications that might build in part upon automatic analyses of facial activity, e.g., lie detection. Simply, as long as there is no reliable evidence of a "Pinocchio Nose" (DePaulo et al. 2003), one should not assume that the recognition of lies by automated procedures is likely to succeed.

This important caveat in mind, some of the emerging mobile devices and new algorithms may however very well be able to help pave the way to a better understanding of real-life social context and its role in the emotion theater. If real-world data can soon be more easily collected on a large scale (see e.g., Picard 2010), then contextual factors may become more visible, which could inform laboratory studies as well as drive intelligent applications that learn to incorporate real-world context effectively into their models. Certainly, basic laboratory research would still be needed for strict tests of data obtained from the field – but the boundaries between basic and applied field research may soon become significantly more permeable.

6 Summary

We have provided an overview regarding the current knowledge regarding facial behavior with a strong emphasis on the link between facial behavior and emotions. We have outlined some of the key theoretical positions regarding facial expressions of emotion because these theories affected research paradigms and the interpretation of findings. Some of the challenges to the field are a consequence of these positions – for example the strict separation between *push* and *pull* in nonverbal behavior. While there is merit to such decisions, it is also of epistemological importance to view the state of the field in the light of the theoretical reasons to look at facial behavior in a particular way.

We have argued that we need to know more about facial behavior in interaction. Very recent developments, particularly from social neuroscience and affective computing, will shape research in the next decades. It is critical that interdisciplinary approaches avoid that old theories get pushed into these new fields; instead, current notions of interaction, cultural differences, and social context should be present there. We argue that knowing what facial activity *does* will help us to understand what facial activity *is*. New developments that involve the implementation of human like artificial systems will impact the study of facial behavior dramatically like no other development in recent decades.

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