

The human face has a main role in theory and research on emotions. A background for this is provided in Chap. 2 by a presentation of the characteristics of the face and a description of Charles Darwin's pioneering views on the function of the facial expressions and their significance for emotions. The chapter comprises sketches of the facial expressions of basic emotions and indications that these expressions may lead by facial feedback to emotional experiences. This leads further to a question of the universality of facial expressions and to a description of Ekman's central studies. The last part of Chap. 2 comprise a discussion of results from a study where persons seemed to be unconsciously imitating other's facial expressions of emotions in ways that suggest a neural mirroring of emotional activation and that emotions may be contagious.

2.1 The Human Face

When you look for emotions in your surroundings they are primarily visible in persons' faces. Actually, this is a practice you have engaged in since you were born. Studies have shown that newborns prefer to look at human faces to other types of stimulation. This may be because the face is a closed form which is easy to grasp, and which is rich in information from contours, symmetrical details and movement. When exploring the face with their eyes newborns inspect mainly the contour of the hair. The inspection of the details of the face starts about a month and a half after birth, with eyes and eyebrows as the preferred targets. Faces, and primarily that of the mother and the father, are the dominating, and possibly the only important, visual stimulus during the first six months of the infant's life (Stern, 1977).

There are several other reasons than visual qualities which attract attention to the face. The face is used when we satisfy our basic needs. We breathe with our nose and we eat and drink through our mouth, and we bolster our security by picking up information from long distances with our eyes and ears. And the face is the source for our use of sounds and language to communicate and interact with other persons. Thus, it is the face we use when we signalize threats, friendliness, disgust, anger and interest, and when we gather information from others.

The importance of the face can be underlined by the fact that evolution has established a specific area for face recognition in the brain. The area is called "fusiform gyrus" and is located in the temporal lobe in the neocortex (see Chap. 11). Persons who have been injured in this area can get «prosopagnosia», which means that they are no longer able to recognize other person's faces.

2.2 The Facial Expressions

Specific facial expressions of emotions such as happiness, anger, and fear are formed by a thin elastic layer of skin fitted on top of an outer and an inner layer of 20 striate muscles. The outer layer consists of many small muscles which influence changes in the forehead (brow), around the eyes and eyebrows and in the mouth and corners of the mouth. The inner layer comprises larger muscles that influence movement in the jaws. Some less used muscles stimulate movements around the nostrils and the ears. Several detailed descriptions of facial muscles can be available by a search for "Facial muscles" and Facial muscles of emotion" on the Internet.

Several attempts at mapping the relations between muscles and facial expressions were made before Charles Darwin presented the results from his studies in 1872. Eight chapters in this book comprise descriptions of 37 emotions and emotional states as well as references to the active muscles which were involved in each case. This was followed up by Tomkins' theory and by studies by Ekman, Izard and the Swedish professor of anatomy Carl-Herman Hjortsjø in the 1960s.

The aim of the mapping was to arrive at exact depictions of the activation of the muscles related to changes in parts of the face for each emotion. Such descriptions can be an objective measure of emotional arousal and a method to identify the type of emotion in each case. There is a pragmatic significance of this which can be associated with the emotional characteristic of selective drivers (see Sect. 1.5). Anger «drives» for instance a person toward direct or indirect aggression, fear to attempts to hide and/or to distract attention to oneself, and sadness to resignation and passivity. This means that nurses, medical doctors, psychologists, psychotherapists, teachers etc. may

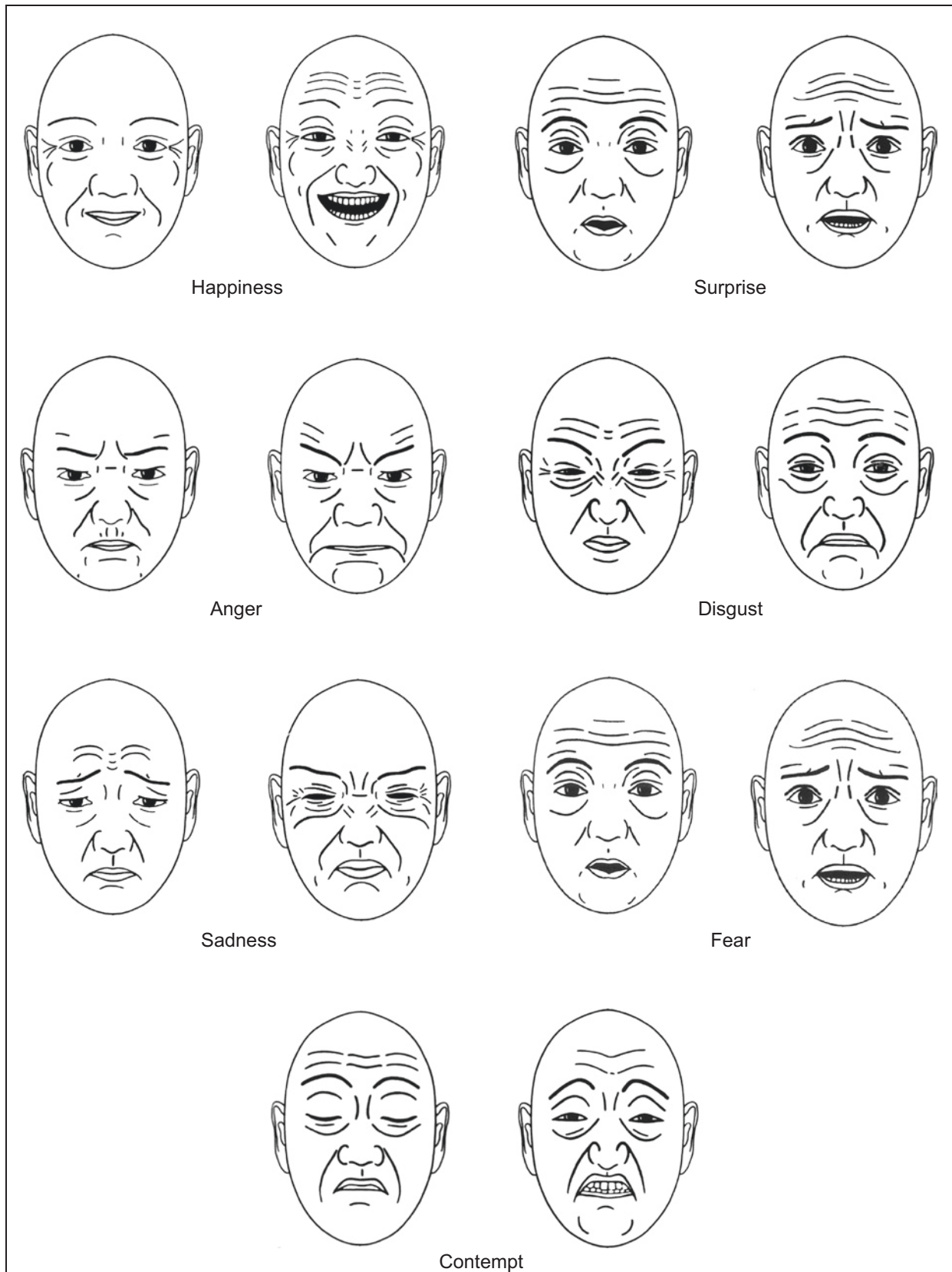


Fig. 2.1 Schematic facial expressions of mild (*left*) and intense (*right*) examples of seven emotions (from Hjortsjø, 1969)

2.3 What Do Facial Expressions Represent?

Table 2.1 Description of facial expressions of nine emotions

Emotion	Description
Interest	Eyebrows lifted and slightly drawn together, eyes follow an object, mouth slightly open and lips pursed
Happiness	Smiling with mouth corners drawn upward, cheeks lifted and a small decrease in distance between eyelids
Surprise	Lifted eyebrows with marked furrows on the forehead, eyes round and mouth open in an oval form
Sadness	Inner part of eyebrows drawn together and narrowing of eyes, wrinkles on forehead and corners of mouth drawn downwards
Anger	Eyebrows drawn downwards and inward, eyes are narrow and staring, forehead smooth, lips pulled tightly, muscles in jaws may be visible
Disgust	Eyebrows drawn downward, upper lip raised and lower lip lowered, nose wrinkled and nasal root widened
Contempt	Mouth corners and eyes lifted, head bent backwards, mouth in scornful grimace
Fear	Eyebrows slightly raised and drawn together with depressed middle part, marked furrows on forehead, eyes wide open with enlarged pupils, mouth open with corners slightly downwards
Shame	Furrows on the forehead, mouth corners pressed together, eyes cast downwards (<i>NB</i> Research indicates low recognition agreement)

Based on Izard (1971) and Hjortsjø (1969)

all profit from being able to read facial expressions to identify students' and patients' emotions and predict their thoughts and behaviors in order to assist their learning and coping. The knowledge of this is also useful to the police, who need to identify those who are most likely to respond with violence, as well as to the customs officer who evaluates if it is necessary to do a further search on somebody who seems anxious for some reason.

A more detailed depiction of the main facial expressions of emotions is provided by Fig. 2.1 (see page 10) and Table 2.1. Figure 2.1 shows schematic drawings of facial expressions of seven of the emotions on Izard's list in Table 1.1. The drawings were made by Hjortsjø (1969), who engaged actors to mime the emotions and used these as models for the drawings. Each emotion is shown in a variation of intensity from mild to intense. Table 2.1 includes all emotions in Fig. 2.1, and comprises short descriptions of the characteristic facial features for the emotions on Izard's list except guilt, which has no recognizable facial expression.

There has been much further development of descriptions and pictures, films and videos for coding facial expressions of children as well as adults. A system which has been widely used is Ekman and Friesen's (1975) FACS (Facial Action Coding System), which consists of 44 units related to electronic coding that renders a very comprehensive description of an expression. This, as well as other face-reading software has been shown to provide quite reliable data for scientific studies.

2.3 What Do Facial Expressions Represent?

Why are emotions expressed openly in facial expressions? Would it not be better if expressions were hidden in ways that each and every one did not have access to one's inner emotions? Most researchers held that it is just the visibility that is the point of the expressions. This is in accordance with Darwin's theory that the function of the facial expression

is communication, i.e. that it is used to tell someone of one's experiences of some stimulus, event, or person.

Darwin proposed that emotions can be recognized in purposive behavior, such as in avoiding something to escape from some danger or attack something in order to obtain something to eat. Some behaviors, he held, are evolved as similar for individuals of a species because they have been shown as useful for the species' survival. After being firmly established because of their survival value they are further employed as means of communication.

A series of studies by Susskind et al. (2008) on human faces show support for Darwin's interpretation in the usefulness of facial expressions. The authors found that the communication of fear by wide open eyes and by disgust with compressed eyes due to the downward drawn eyebrows (see Fig. 2.1 and Table 2.1) were associated with, in comparison to a neutral expression, respectively, a larger and a reduced visual field, an increased and a reduced detection of objects, faster and slower eye movements and increased and reduced air respiratory volume. The differences were related to regulation of sensory information that enhances the detection of threat in fear and dampens the unpleasantness of the information in disgust.

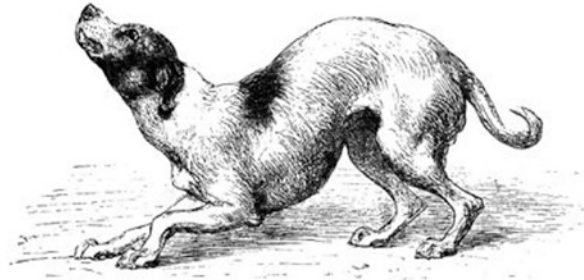
Darwin's examples of behaviors in animals which are shown in Fig. 2.2 (see page 12) depict an approaching and threatening dog with bared teeth and one which is submissive and appealing which does not seem to be engaged in goal-oriented behavior. The same is true of the fearful and angry cats. All four seem, rather, to expressing something which "tell" or "communicate" something that might happen or is about to happen.

Darwin held that expressions are almost exclusively used as communication in humans, and that expression and emotion are more or less the same in both animals and man. This can be confirmed, he argued, by the fact that an emotion is more or less intense depending on the intensity of the expression. This means that the emotion is considered as more or less identical to the emotion, i.e. that the expression *is* in fact the emotion, which may be why Darwin did not seem to need a separate definition of emotions.

There is not much disagreement that emotional facial expressions can be a rich and easily accessible source of communication. Most persons will not have problems in using their faces to communicate to someone that an object is attractive,



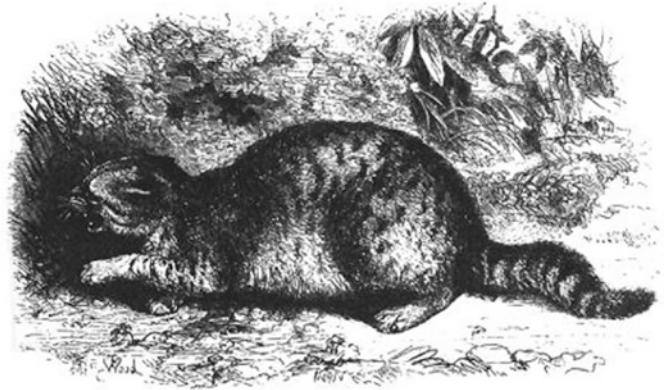
Threatening dog



Devoted and affectionate dog



Frightened cat



Angry cat

Fig. 2.2 Examples of emotional expressions in animals (from Darwin, 1872)

dangerous or without interest, or that it is good or bad. They will also almost as easily use emotional expressions to communicate relations, such as: «Stay with me», «Come to me», or «Get lost». These are examples of the analog-as distinct from verbal- or digital communication. Analog communication consists of the use of facial expressions as examples or symbols of the message in communication. Thus, it refers to something by being similar to, taking part in, or imitating that which is referred. The dog's bared teeth in Fig. 2.2 form an expression which refers to a rage that implies biting with bared teeth. Another example may be that crying is partaking in the experience of sadness and hurt which is referred to by the facial expression of crying. References of digital, verbal communication are, by contrast, only fortuitously related to that which is referred. Words such as "anger" and "sadness" refers, respectively, to provocative and painful experiences only because of a convention, i.e. because persons agree that this are words which can be employed in certain contexts.

Researchers have proposed that the human face with its scarcity of hair as compared to other animals, and with its

layers of muscles to vary the forms of the skin, has been developed in order to increase human's communicative skills. This has been interpreted as the response to a large new need to be able to identify and encode interpersonal signals which emerged when human groups increased in the Pleistocene-period, a period of almost 2 million years for more than 10,000 years ago when the human brain increased three times in size (Baron-Cohen, 1995).

Darwin's view on the close relation between expression and emotion has been especially related to facial expressions in modern theories and research. Izard (1971) held, for instance, that the expression forms a pattern of stimulation on the inside of the face with information to the brain. He assumed, furthermore, that this information, together with information from the body and the senses, leads to the experience of an emotion. The viewpoint can be simplified in a hypothesis that the facial expression causes the emotion, which means, e.g. that you will become happy from smiling and sad from crying. The hypothesis is known as "the facial feedback hypothesis", and has been tested in several studies.

2.4 The Facial Feed-Back Hypothesis

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There are different examples of the facial feed-back hypothesis. The most simple and direct type is the proposal that activation of the facial muscles for the expression of an emotion results in information to the brain which leads to the stimulation of an experience of the corresponding emotion.

The hypothesis can be tested by instructing participants without any specific emotion to simulate the expression of an emotion with awareness neither of the emotional significance of the expression nor the fact that the test is related to emotions. The procedure need to include a measure of emotional experience. A very simple and ingenious study along these lines started with instructions to participants that they should read some comic strips and rate the enjoyment of each strips a measure of their emotional experience (Strack, Martin, & Stepper, 1988). Half of the participants in the study were required to hold a pencil with their lips, and the other half to hold a pencil with their teeth when they were reading the comic strips and rating their enjoyment. The point of the procedure is that a pencil held between the teeth provokes a smile, which is a main component of the expression of happiness; whereas a pencil held between the lips have no such effect.

The results were that the participants with artificial smiles because of a pencil between their teeth rated their enjoyment of the comic strips as significantly greater than those who held a pencil between their lips. Enjoyment is an indication of happiness, and the results can, consequently, be considered as support for the feed-back hypothesis.

Duclos et al. (1989) showed that the effect was not limited to positive emotions. The researchers instructed participants who were listening to neutral music to activate facial muscles in ways which produced expressions of fear, anger, disgust and sadness. Emotions were not mentioned in the instructions. Testing consisted of ratings of the intensity of several emotions after the music was stopped. Results supported the feed-back hypothesis by showing higher ratings of the intensity of the emotions which were inadvertently presented by the participants themselves than for other emotions. Several other studies have provided similar support (McIntosh, 1996). A rather original example was an experiment using the neuroxin botulinium («botox»), which paralyzes the facial muscles and is used cosmetically because this hampers the aging process and the development of wrinkles in the face. The results of the experiment were that the injection of botox, which blocks information to the brain, lead to a decreased ability to identify emotions in human faces (Neal & Chartrand, 2011).

Results from studies on several forms of emotional expression indicate that feed-back is not limited to facial stimuli. Persons who have been asked to imitate the bodily carriage characteristic of anger, fear, and sadness have shown higher ratings for the corresponding experiences than for other emotions. Participants in one study were asked to assume the shriveled, forward bent with downcast face bodily carriage typical for depressed persons. The results from the study

showed reports of less pride and more negative emotions in these persons than from participants who did not imitate the depressive body. It has also been shown that instructions to talk with a “glad” or a “sad” voice resulted in increases in corresponding ratings of emotional experiences.

Actors are very little surprised by these results. They have, since early in the twentieth century, been practicing “method acting” as taught by the instructor Constantin Stanislavski, who held that the imitation of emotional expressions led to emotional experiences that could be performed in a credible way on the stage. This was a central principle in the education of several of the best-known movie «stars», e.g. Marlon Brando, Marilyn Monroe, Robert de Niro, and Jack Nicholson.

It should be noted, however, that participants in the studies which were cited rated their emotional experiences as “mild”. And, furthermore, that stroke patients who have lost their ability of facial expressions (the Mobius syndrome) are nonetheless able to experience emotions. This may suggest that facial expressions may contribute only in part, or may not even be necessary for emotional experiences provided, as is the case with stroke patients, that they have long experience with and have retained the ability to imagine facial expressions.

2.5 Universal Facial Expressions

It was a domineering assumption for many years that facial expressions depended on culture and was, consequently, different from one culture to another. It was ignored or forgotten that Darwin, after receiving responses to questionnaires about children’s and adolescents’ emotional expressions from missionaries all over the world, concluded that the expressions of several emotions were actually rather similar (see also Chap. 9).

The domineering influence was greatly reduced when Darwin’s work was «rediscovered» in the 1960s (see Chap. 11), and new studies related to his findings were designed by Paul Ekman (1973) and Carroll Izard (1971). The most carefully prepared project was carried out by Ekman, and is regarded as a «classical» study in modern research on emotions. Ekman and his co-workers began by inspecting and evaluating around 3000 photos of the faces of adults in order to obtain a representative sample of expressions of various emotions. The photos were all showing white North-Americans, and comprised both spontaneous and posed expressions. Some of the photos were of the researchers themselves, but most of them were selected from diverse sources. A constraint on the selection was that the expression which was shown should correspond to the activation of the corresponding facial muscles.

Ekman’s final sample comprised 30 photos of 14 different persons, and referred to six photos of each of the emotions happiness, sadness, anger, fear, surprise, and disgust. Participants from five different countries were shown the photos

and were tested for their identification of the emotion on each photo by pointing to a list of words for different emotions. Examples of photos and results from Ekman's study are shown in Fig. 2.3 (see page 15). The numbers in the figure represent percentage of agreement about the emotions shown in photos of facial expressions of emotions among respondents from each of the five countries. Figure 2.3 shows, for instance, that 97% of U.S. participants and 95% of Brazilians agreed that photos of happiness pertained to happiness, that 68% of Chileans and 85% of U.S. participants agreed that fear photos showed fear, and that 90% of the Japanese and 92% of the Argentinians have agreed that the photos of disgusting facial expressions pertained to disgust.

The results can generally be interpreted as showing a high degree of agreement about the facial expression of the six emotions which were entered in the study. Ekman pointed out that the results pertained to persons from four different languages (English, Japanese, Portuguese, and Spanish) and from three cultural groups (Anglo-American, Latin-American, and Japanese). The results from Izard's study showed similar levels of agreement for the same emotions as Ekman's among participants from European countries (England, France, Germany, Greece, Sweden, and Switzerland). Agreement was, however, much lower for shame than for the other emotions, and lower among participants from Japan and Africa. The latter seemed to be due to the fact that these participants were the only ones who were not tested in their natural language.

The results show some variation in agreement for different emotions. Both Ekman's and Izard's study showed highest agreement for happiness, surprise, and disgust, and somewhat lower for fear and anger. This can be due to several factors. The photos for some of the emotions may, for example, have been slightly clearer or more characteristic of the emotion in question than others. It can also be assumed that the results were affected, as was noted by Ekman, by cultural variation in language and the frequency of emotional expression in a country or culture. Anger, which showed the lowest percentage for Japan in Fig. 2.3, is for instance very controlled and seldom shown openly in Japanese culture. Infrequent experience with expressions of an emotion may result in insecure identification of a pictured emotion, and in lower agreement about these pictures both within a across cultural groups.

Criticisms of Ekman's studies were mainly directed at Ekman's method. A central objection was that agreement among participants was inflated by the use of a list of words where only one of them pertained directly to the photograph (Russell, 1994). This argument is countered by the fact that the participants in Izard's (1971) study, which yielded similar results to Ekman's, responded by using free descriptions of the expressions, as well as by alternative methods with variations in the contents of the response lists. Subsequent research has generally been supportive for Ekman's results, but has also confirmed that there may be some cultural variation in recognition (or clarity) of facial expressions. It has, for example, been shown that agreement on facial expressions for pictures of persons within a culture is larger than for pictures of persons from another culture.

It may be noted as a summary of this research that studies of recognition of facial expressions have provided stable evidence that the expressions have a universal form, at least for

the emotions which were employed in Ekman's study. This has been interpreted by Ekman and Izard, following Darwin, to mean that the facial expression mirrors a human "nature" which is hardwired and coded in a neurological program. Indications of universality are often used in this way to support biological explanations and to conceive of emotions as basic, but this is weakened by the fact that social emotions do not show universal facial expressions. It should also be noted that the studies pertain to facial expressions and not to emotions. Studies on the recognition of emotions should need to include indications of typical contexts and/or scenes in addition to depiction of facial expressions (see Sect. 9.3).

2.6 Facial Expressions as Subcortical Stimulation: Dimberg, Thunberg, & Elmehed's (2000) Study

The face and its expression are, as was hinted at in Sect. 2.1, not any stimulus. It is among other things also a stimulus which seems to trigger imitation. Meltzoff and Moore (1983, 1989) showed in a series of well-known studies that newborns imitated another person's facial changes, such as opening and closing of the mouth and protrusion of the tongue. As this imitation is scarcely based on conscious experience by the newborn, it can be assumed that it related to the subcortical structures which were the basis for responses in Öhman and Soares' (1994) study cited in Sect. 1.7.

The significance of a subcortical imitation of facial expression is that this may mediate an "infection" of emotion from one person to another by facial feed-back. This is further discussed in Sect. 4.6. A study directly related to the emotional response to subcortically presented stimulation has been conducted Dimberg, Thunberg, and Elmehed (2000). The study comprised three groups of students as participants. The procedure started with participants (individually) in front of a PC which showed enlarged photos of a neutral face for a first group of participants, a face with an angry expression for a second group, and a face with a happy expression for the third group. The photos were shown in 30 ms and were either presented openly (the neutral photo) or were immediately followed (photos of angry or happy expressions) by neutral photos in 100 ms according to the backward masking method (see Sect. 1.7). The participants were, consequently, not able to be aware of or to remember the emotional expressions. Responses were measured in terms of miniature electrodes on the facial muscles zygomatic major and corrugator supercilii, which are active in, respectively, the facial expressions of happiness and anger. This measurement is known as electromyography (EMG).

The results from the study indicated a more vigorous arousal in the "angry" corrugator than in the "happy" zygomatic, but the main point was that the "happy" zygomatic was clearly more strongly activated by presentation of the happy than by the angry stimulus face, whereas the "angry" corrugator showed

2.6 Facial Expressions as Subcortical Stimulation: Dimberg, Thunberg, & Elmehed's (2000) Study

Fig. 2.3 Percentage agreement in how photographs were judged across cultures (from Ekman, 1973)

Percentage Agreement in How Photograph Was Judged Across Cultures					
	United States (N=99)	Brazil (N=40)	Chile (N=119)	Argentina (N=168)	Japan (N=29)
	97% Happiness	95% Happiness	95% Happiness	98% Happiness	100% Happiness
	92% Disgust	97% Disgust	92% Disgust	92% Disgust	90% Disgust
	95% Surprise	87% Surprise	93% Surprise	95% Surprise	100% Surprise
	84% Sadness	59% Sadness	88% Sadness	78% Sadness	62% Sadness
	67% Anger	90% Anger	94% Anger	90% Anger	90% Anger
	85% Fear	67% Fear	68% Fear	54% Fear	66% Fear

the opposite low activation of the happy and much stronger activation after the angry face. Or, in other words, a happy face triggered a response in perceivers' "happy-" and an angry face triggered a response in their "angry" muscle.

Dimberg et al.'s study showed, then, that there was muscular activity in participants' faces corresponding to emotional expressions in another face which they were not aware of. This can be interpreted as an unconscious, emotional imitation where the emotional expression in one person's face may evoke some resonance through facial feed-back in another. This is a subcortical imitation that shows a parallel to conceptions in modern neuroscience that humans participate in each other's neural networks. A basis for this concept is the discovery of "mirror neurons", i.e. neurons which are activated in the same area of the brain in a seated person as the neuronal activation in a person who is observed by the seated person to perform some active task. The seated person's neuronal activation in this instance can be said to mirror the neuronal activation of the active person. Mirror neurons were originally discovered in apes by researchers in Parma in Italy (Rizzolatti, Fadiga, Gallese, & Fandassi, 1996), and have been shown in humans by a large number of studies, including studies of muscular activity in the face (Enticott et al., 2008). The neurons have been interpreted by researchers as examples that humans participate and share each other's experiences (Gallese, 2003, 2011), but there is some controversy whether this extends to the emotions (Decety, 2010).

2.7 Practical Relevance

Facial expressions are directly related to communication on different levels. It can stimulate improved communication on the personal level by providing a standard for practice both in recognition of emotions in others and in heightening one's own consciousness as regards one's communication of emotions to others. Group practice with miming is often an enjoyable as well as a useful experience in this context. The identification of the main muscles of the face may serve as useful cues. On the level of official and electronic communication there is a large and underdeveloped potential to use easily identifiable facial expressions as indicators that can clarify and/or reinforce verbal directions and explanations which are often long, abstract and complicated. Facial expressions are used as an analog language long before children learn to speak (see Chap. 5), which also suggests a level of international, or global communication where communicative doors may be opened with the use of the facial language.

There is a large application based on the detailed descriptions of facial muscles as regards identification and treatment of human problems. Examples are that patients with Huntington's illness have been shown to have problems in identifying negative emotions, especially anger, that patients with Parkinson's illness have problems in identifying sadness and fear, that patients with Alzheimer's disorder have problems in identifying sadness, and that persons with Asperger's syndrome

show a general problem in recognizing all basic emotions. Studies have also shown large problems in identification of emotions in persons with schizophrenia, obsessive-compulsive disorder and depression.

2.8 Summary

The face is a primary arousal of attention and a center of the expression of many, perhaps most of the emotions. Variations in expressions are based on the activation of two levels of muscles that are activated separately to form the skin in different ways.

Darwin noted similarities in expression of emotions in animals and man and conceived of a very close relation between the expression and the emotion. He also held that the expression was based on inherited circuits in the brain, and that the expression functions mainly as communication in humans.

Tests for the relation between facial expression and emotional experience, which has been stated as a feed-back hypothesis, have shown that simulation or imitation of the facial expression of an emotion may lead to experiences of the corresponding emotion.

Darwin's concepts of the universality of emotional expression has been rediscovered and tested by several researchers. The main study was conducted by Ekman, and showed, in support of Darwin, a high degree of agreement about the facial expressions for happiness, surprise, anger, sadness, fear, and disgust among participants from different languages and cultures.

Observations of newborns' imitation of facial characteristics lead to the assumption that emotional facial expressions may be imitated (and infected) at a subcortical level. The feasibility of this conception was demonstrated in Dimberg et al.'s study, which showed that observer's emotional facial muscles were activated by photos of emotional facial expressions which the observers could not be consciously aware of. This unconscious imitation may be a parallel phenomenon to mirror neurons.

Reflection Questions

1. What would be the consequences if you and/or your closest persons were: (a) Able to control your facial expressions perfectly? (b) Were without any variations in facial expressions whatsoever?
2. What may be consequences of people's subconscious emotional responses to other person's facial expressions? Could they be limited to only a few emotions?

Research/Exercise Examples

1. Find descriptions of facial muscles on the net which can be used to identify the facial muscles zygomatic and corrugator in your own and your study colleagues' faces.
2. Facial expressions which are universal and inherited should be immediately accessible for imitation. Test this assumption by recording the time it will take a participant in a study-group to imitate an emotion on request.

2.8 Summary

3. Test your reading of facial expressions by positing yourself at a place where you can watch persons passing. Note for each person if you can identify a specific emotion and your confidence (insecure—moderately secure—very secure) in the identification. Note also the sex and approximate age (child, adolescent, young adult, older adult) of the person. To what extent do you think the results reflect your ability to identify, the accessibility of facial expressions or the subject (type of person)?

Further Reading

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