

# The influence of eyebrows on the recognition of the emotions happiness and fear

The influence of facial characteristics on the perception of others.

## De invloed van wenkbrauwen op de herkenning van de emoties blijdschap en angst

De invloed van gezichtskenmerken op de waarneming van anderen

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## **Abstract**

The main purpose of this study was to investigate to what extent the recognition of emotions relies on the presence of eyebrows. An important way of expression in humans, is our facial expressing when experiencing certain emotions. Humans visualise expressions in their face by using certain facial muscles. Eyebrows are of importance in the creation of facial expressions. Without them, humans are not able to create genuine expressions (Ekman, 1992). The current study is based on the research done by Sadr et. al (2003) about identifying someone by the eyebrows and on research done by Ekman (1997) involving the recognition of emotions on someone's face. In the current study, the influence of eyebrows on the perception of happiness and fear was investigated in a behavioural experiment among 30 students from Nijmegen aged between 18-25. Results showed that the presence or absence of eyebrows did not influence the recognition of emotions. The current study found that happiness was recognised more easily compared to fear. The results provide valuable information about the recognition of emotions of people in relation to subtle visual cues such as eyebrows. This might imply that a single facial cue might not be of importance in recognition of emotion during, for example, a social interaction.

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## 1. Theoretical Background

### 1.1 Expressing emotions

Humans can express their current state of mind in multiple ways. They raise their voices when they are angry or lower their voice when they are embarrassed. They can tilt their head when they are unclear of what you mean or when they are annoyed and can use their hands in expressing their anger or joy.

Expressing one's state of mind can be done with the entire body to show what is felt at that moment. Another important way of expressing emotions, is our facial expressing when experiencing certain emotions, raising the eyebrows when one is surprised or wrinkling the nose when one is mad for example. Emotions and expressing them started being studied over a century ago. Expressing oneself is something humans naturally do and researchers have questioned many different aspects as to why people express their emotions through their faces and which part of their faces show which specific emotions. Many experiments have been conducted throughout the years and theories have been forged that try to explain how and why humans express emotions. It is a vastly researched subject but there are still many questions that are left unanswered. However, the fact that people express their emotions through their bodies has been agreed on by all researchers (Tomkins, 1963; Ekman, 1993; Ekman, 2016).

### 1.2 Early Research

Throughout the years we have gained knowledge about emotions and expressing them.

One of the first to study expressions was Charles Darwin (1872). In the book "*The Expressions of the Emotions in Man and Animals*" (Darwin, 1872), the different reasons for animals to express emotions have been explained. He researched this by observing live animals and their way of interacting with one another. He found that animals show expressions as a way to show other animals what their rank is in their group. It was also a survival mechanism to scare off enemies. These findings were compared to the reasons humans express their emotions. Humans show emotions as a way of showing their status within a group and often express emotions when they are in an unfamiliar environment. These results demonstrated that animals and humans do have the same reasons for expressing emotions, namely trying to predict behaviour of others in order to get through certain interactions (Darwin, 1872).

Ekman (1993) added that we also show emotion through dynamic events, such as thunder. In this case, emotion is depending on the context the person is in.

Experiencing emotions and expressing them is a cognitive process that has not only a survival function as Darwin (1872) mentions, but also works as an interpersonal function between two humans and as an intrapersonal function within one's own mind (Weiner, 2000; Levenson, 1999). Humans express how they feel when communicating with others. Showing their current mood through their face is a way of creating relationships with other humans (Darwin, 1862)

Pleasantness or unpleasantness are general statements which do not specify which emotion the person is expressing. For example, surprise can be both a pleasant and an unpleasant emotion, which means it can be put in both categories. These terms are unclear and do not give an answer to what specific emotion a person is showing (Singer & Schachter, 1962). There is a great number of emotions that humans can accumulate, but each person expresses it in a different way. Schachter and Singer (1962) found that specific emotions cannot be concluded from facial features only, because even the slightest difference in emotion of the person can change their face entirely. This makes it difficult to determine which specific emotion an individual is expressing. Ekman (1977) found that there are many facial cues that are universal in expression, but some specific features are only shown by certain individuals and these features are specific to their personality (Ekman, 1977).

Ekman (1977) established that there are six different emotions that we recognise no matter which individual is expressing them. These emotions are called the *discrete emotions*. These emotions are happiness, sadness, anger, fear, surprise and disgust. Happiness is overall perceived as the most easily recognisable emotion on human faces (Ekman, 1977; Ekman, Friesen & Ellsworth, 1972). To verify the statement about the *discrete emotions*, Ekman (2016) researched if these emotions are recognised as the basic emotions by a total of 150 scientists who study emotions. Happiness, sadness, anger and fear were recognised between 75-100 percent of the time, which verifies the earlier statement of Ekman (1977).

### *1.3 Creating Expressions*

We visualise our expressions in our face by using certain muscles. Many researchers have constructed different sets of combinations of which muscles elicit which emotions (Duchenne, 1862; Darwin, 1872; Hjärtstjör, 1970; Ekman, 1972; Ekman & Tomkins, 1962). Duchenne (1862) was the first to research facial muscles and their influence in creating expressions. He created a table that shows which muscle(s) create which emotion. He researched this by using electro technical technologies to let the muscles in the face contract.

Every muscle in the human face was tested, but not every muscle elicited a specific emotion. The biggest limitation was that often facial muscles were overlapping, which means that there is no specific muscle used for one specific emotion. For example, when one is raising the eyebrows and opening one's mouth, this can be done in surprise, but can also be done when one is afraid. For these expressions, more muscles are used than only the ones to change the eyebrows, but on first impression it might not be clear which emotion is being showed. In his book, Darwin (1872) builds on the research Duchenne has done on the contractions of the facial muscles. This included more specific ways that the muscles contracted in what situation (Darwin, 1872). Together with Hjärtstjöö (1970), Duchenne and Darwin laid the foundation for the research of the visualisation of emotions and expressions.

In their book, Ekman and Friesen (2003) differentiate 3 types of signs with which one can recognise emotions of others in their faces. These signals are *static signals*, *slow signals* and *rapid signals*. *Static signals* are the features that are permanent, such as shape of your face and pigmentation. *Slow signals* are for example wrinkles and other facial features, such as skin colouring and skin texture, which have (slowly) developed over time. In the current study the focus lies on the *rapid signals*, which create one's facial expression. These *rapid signals* are produced when one is contracting their facial muscles, which result in a temporary change of one's facial appearance. These facial changes are often visible for a few seconds or fractions of a second (Ekman & Friesen, 2003)

#### 1.4 Eyebrows

An important example of a rapid facial feature are the eyebrows of a person. The eyebrows can show much information to other people when communicating with one another. The question as to why humans and animals have eyebrows has mainly been questioned by evolutionary researchers. The main use of the eyebrows is to protect our eyes from perspiration that has accumulated on the forehead when it is, for example, hot (Darwin, 1862; Sadr, Jarudi & Sinha, 2003). Eyebrows also show us the difference between females and males, as male eyebrows are thicker than women's (Sadr et. al, 2003). Sadr et. al (2003) also found that the eyes and mostly eyebrows are necessary for recognising other humans. Without the eyebrows, one is less able to determine someone's identity (Sadr et. al, 2003). Baker-Schenk (1985) mentioned in her study that eyebrows also play an important part in expressing non-verbal communication, by making expressions that have the same meaning as words. For example, raising the eyebrows can mean "*you know as much as I do*" as an answer to someone's question.

Another important function of eyebrows is the creation of facial expressions, through which we are able to determine someone's emotions (Sadr et. Al, 2003). The difference between a positive and negative state of mind can also be shown in the face by using the eyebrows (Dimberg, 1990). When one is happy for example, the eyebrows are often lifted and arched upwards to a rounder shape and when one is angry, a frown will arise on one's face (Ekman, 1977). Ekman and Friesen (1976) researched the facial expressions humans make and divided the face in three regions. These consisted of the upper part of the face, which consisted of the use of the eyebrows and forehead; the middle part of the face, consisting of the eyes and cheekbones; and the lower part of the face, which consisted of the nose, mouth and the chin (Ekman & Friesen, 1976). In their study they established that the upper part of the face, and mainly the eyebrows, were most important in creating the six *discrete emotions* (Ekman, 1977).

This applied to the visualisation of the emotions happiness, surprise and anger. Sadr et. al (2003) came to the same conclusion. In figure 1 below it is visible that with only altering the eyebrows, one is able to change their expression entirely (Sadr et. al, 2003).



Figure 1. Cartoon drawing of the influence of the eyebrows. (Left, neutral; Middle, surprise/fear; Right, anger)

Artist Unknown (March 7, 2003). Retrieved from: [http://ghk.hcdn.co/assets/cm/15/11/54ffe71e81570 - sinha\\_eyebrows.pdf](http://ghk.hcdn.co/assets/cm/15/11/54ffe71e81570 - sinha_eyebrows.pdf)

### 1.5 Aim of the study

Based on the presented information, the importance of the eyebrows in creating facial expressions is clear. Without them, humans are not able to create genuine expressions (Ekman, 1992). The effect of the absence of eyebrows on the recognition of people and emotions has also been tested (Sadr et. al, 2003; Ekman, 1993). In their study, Sadr et. al (2003) researched if the absence of eyebrows on pictures of famous people would influence the ability by participants to recognise them.

Only 46.5% of the participants were able to recognise the celebrities. They came to the conclusion that not only are they of importance for creating facial expressions, eyebrows are also of importance for recognizing people. This study is set out to further establish the findings of Sadr et. al (2003) and Ekman (1993).

In this study however, the influence of only one facial cue, namely the eyebrows, was researched in relation to the recognition of emotions. This has been done, to be able to determine if one specific facial cue can influence the recognition of emotions and may contradict or validate the results found by Sadr et. al (2003) and Ekman (1993).

The current study is based on the research done by Sadr et. al (2003) about identifying someone by the eyebrows and on research done by Ekman (1997) involving the recognition of emotions on someone's face. Ekman and Friesen (1976) mentioned in their study that the muscles around the eyes are most important in creating expressions of emotions. The influence of the absence of eyebrows on the recognition of famous people as been researched by Sadr et. al (2003). The current study will study the influence of eyebrows on the recognition of emotions. The current study will thus also build on the research done by Ekman and Friesen (1976) on recognition of emotions by facial features.

### *1.6 The chosen emotions*

In this study happiness and fear were chosen to be investigated. They are distinguished as respectively a positive and negative emotion and illustrate the contrast between those two states. In this study, happiness is chosen as one of the emotions that was researched, because it is the most positive emotion out of the "*discrete emotions*" (Ekman, 1977). Ekman and Friesen (1971) also stated in their article that happiness is the emotion that is the easiest to recognise universally. Of the "*discrete emotions*" fear is one of the five emotions that shows a negative state of mind. It has been established by Ekman and Friesen (2003) that fear is an emotion that is not universally recognised and can be easily confused with, for example, surprise. Fear is chosen to be investigated because it is the opposite of happiness in both state of mind and in complexity of recognition.

### *1.7 Hypotheses*

As the aim of this study is to further determine if the absence of eyebrows are of influence on the recognition of emotions, the following hypotheses were chosen to be tested.

**H1 Emotional facial expressions with the absence of eyebrows will be recognised less frequently compared to the same expressions with eyebrows.**



Data from several studies suggest that the eyebrows are of high importance in recognising a person and the emotional state of that person (Sadr et. al, 2003; Dimberg, 1990). Ekman and Friesen (1976) also mention that the muscles around the eyes are of the highest importance in recognising emotions. The literature revealed few studies which researched the influence of the absence of the eyebrows on the recognition of emotions. Contrarily to the results of earlier studies, it is expected that people will not be as easily able to recognise expressions of emotions without the eyebrows present. This hypothesis was tested on the accuracy of the correct answers given and reaction time of the participants in the experiment. The reaction time will determine the thinking process of the participant and may show a difference in reaction time due to the absence or presence of the eyebrows.

It has previously been observed that happiness is the emotion that is universally the easiest to recognise (Ekman & Friesen, 1971). To further establish this finding, it is to be expected that happiness will be recognised most in emotional expressions with and without eyebrows. Not only a difference in accuracy, but also a difference in reaction time is expected. Fear, however, is often confused with surprise (Ekman & Friesen, 2003) and is recognised less easily compared to happiness (Ekman, 2016). That is why there is an additional hypothesis added, which will reveal if this is also the case for the emotional expression without eyebrows.

## **H2 Happiness will be recognised more frequently compared to fear.**

In the following section of this study, the method of this experiment will be explained. An explanation will be given about the participants who have participated in the experiment, what materials have been used, the procedure of the experiment and an explanation about the design of the experiment.

## 2. Method

### 2.1 Materials

Ekman, Friesen and Ellsworth (1972) mentioned in their study that still images might not be appropriate to elicit results from participants, because creating expressions is a process that takes time. It is, however, appropriate to use these still images if the interest lies within the use of muscle actions of facial movements (Ekman et. al, 1972). The pictures that have been used in the experiments are from the validated set created by van der Schalk, Hawk, Fisher, and Doosje (2011) called the ADFES (Amsterdam Dynamic Facial Expression Set). This set consists of 648 pictures of people from different ethnic backgrounds expressing emotions. The people photographed were modelled to make the expressions as similar to one another as possible. Afterwards, participants were asked to choose the emotion that was shown in the picture. The results were positive and thus it became possible to use this set for other studies.

For this experiment, a selection of 22 pictures from the ADFES database (van der Schalk et. al., 2011) was used. As an illustration, an example of four pictures with and without eyebrows can be found in Appendix 1. A total of two pictures were used in the practice sessions of the experiment. The person in both pictures was male. In one photo he showed the emotion fear and in the other photo the emotion happiness. In the main experiment, 10 pictures that visualised the emotion happiness were selected, the other 10 visualised the emotion fear. Half of these pictures showed a female visualising the emotion, the other half showed males visualising the emotion. Additionally, these 22 pictures were edited to have the eyebrows digitally removed and added to the other 22 pictures, leading to 44 pictures in total (22 with and 22 without eyebrows). Participants were thus exposed to a total of 44 pictures, 4 in the practice segment and 40 in the experiment.

The program that was used to facilitate the experiment was OpenSesame (Mathôt, Schreij & Theeuwes, 2012). This program was downloaded online for free. It is specifically made for creating experiments for psychology, neuroscience and experimental economics (Mathôt, et. al, 2012). OpenSesame made it possible to randomise the order of the pictures that were shown during the experiment. Every participant got to see the same pictures but in a random order.

## 2.2 Participants

A total of 30 participants took part in the experiment (age:  $M = 21.07$ ,  $SD = 1.64$ ; range 18-25; 90% female). All participants were students Dutch from Nijmegen aged between 18 and 25. The majority of the participants reported to have a Bachelors' degree (90%). The rest of the participant reported to have followed a different form of higher education (10%).

## 2.3 Design

The design of this experiment was a within-subject design. Every participant was shown the same pictures in every experiment trial round. The experiment has a 2x2 design with *eyebrows* (present and absent) and the *emotions* (happiness and fear) as the independent variables. The *recognition of emotions* (levels recognition or no recognition of the emotions) and *reaction time* (in milliseconds) were the dependent variables that have been measured.

## 2.4 Instrumentation

The variables that were measured in this experiment were the recognition of the emotion (correct and incorrect) and the time it took for participants to answer the question (in milliseconds). Every participant was exposed to 44 pictures, of which four pictures were part of the practice segment of the experiment. After participants were exposed to a picture, participants were asked to answer one open answered question "*What emotion did the person in the picture show?*" Participants could choose between four answers, namely happiness, fear, surprise and embarrassment. Four answer choices were chosen to answer the question. This was done, because it would otherwise be easy to indicate whether the emotion was positive or negative and answer accordingly. Surprise was chosen as it is often confused with fear and vice versa (Ekman & Friesen, 2003). Embarrassment was chosen, because it is part of the same emotional family as fear and surprise (Ekman & Friesen, 1971), which means that they often show the same facial features when expressed. For every picture there was only one correct answer, either fear or happiness. The accuracy was measured by the amount of correct answers given to the question.

The reaction time was measured from the moment the question and answers about the showed picture were visible until the moment the participants pressed the button to answer the question. The reaction time was measured in milliseconds.

The accuracy and reaction time were measured for all combinations of the conditions; Pictures of the expression of happiness with and without eyebrows and pictures of the expression fear with and without eyebrows.

### 2.5 Procedure

The participants that took part in the experiment, were personally asked to participate in the experiment. Participation was voluntary, as there was no incentive to persuade people to join the experiment. Participants were informed about the duration of the experiment and that the results were going to be used for a bachelor thesis. The experiment was created and could only be opened in OpenSesame on the researcher's PC, which means that the researcher was there when the participant did the experiment. The experiment was conducted individually. The participants were not informed about the aim of the study.

Participants were shown the introduction screen of the experiment which thanked them for their participation and explained how the experiment would proceed. They were informed that the first part of the experiment was to practice and familiarize themselves with the task given.

The trial procedure of the practice session started with a black screen for one second, followed by a screen with a dot for another second and afterwards immediately the picture of the person showing the emotion. The picture was visible for 100 milliseconds. After the picture was shown another black screen was showed for one second, which was then proceeded by the question. The question "*What emotion did the person in the picture show?*" was written in white on a black screen. Underneath the question were four options to answer the question. The answers participants could choose from were 1 = happiness, 2 = fear, 3 = surprise, and 4 = embarrassment. The numbers represent the button they had to press to answer the question. After participants answered the question another black screen was shown for one second. After this cycle, the program continued with the next trial. The practice segment contained only four trials, which were not taken into account for the analysis of the results.

After the practice segment, participants were informed that they finished the practice segment and were starting the actual experiment. The experiment had exactly the same trial procedure as the practice session. In total, 40 trials were presented to the participants in random order. This means that there was only a small chance that participants were exposed to the same cycle of pictures.

At the end of the experiment the participants were thanked again for their participation and were informed that they could ask the researcher questions about the experiment. The experiment was conducted in a public space, which may have had influence on the concentration of the participant. The duration of the experiment was approximately 10-15 minutes per participant.

### *2.6 Statistical Treatment*

To answer the hypotheses a set of paired samples t-tests were done to see if there were differences between two conditions.

## Results

### Accuracy

The main purpose of this study was to investigate to what extent the recognition of emotions relies on the presence of eyebrows. Table 1. presents the means and standard deviation of the correctly identified emotions on all combinations of stimuli.

Table 1. Percentage of correct answers per experimental condition (n=30) ( $M$  = mean,  $SD$  = standard deviation).

Condition	$M$	$SD$
Fear	52.53	15.28
Happiness	93.33	12.07
Without eyebrows	73.50	10.77
With eyebrows	72.50	10.97
Fear with eyebrows	54.33	17.56
Fear without eyebrows	49.33	18.18
Happiness with eyebrows	93.67	13.88
Happiness without eyebrows	94.00	11.62

A paired samples t-test showed a significant difference between the percentage of correct answers for happiness compared to fear ( $t(29) = 10.82, p < .001$ ). Happiness is better identified as such ( $M = 93.33, SD = 12.07$ ) compared to Fear ( $M = 52.53, SD = 15.28$ ).

A paired samples t-test showed no significant difference between the percentage of correct answers of pictures without eyebrows compared to pictures with eyebrows ( $t(29) = 0.47, p = .641$ ).

A paired samples t-test showed no significant difference between the percentage of correct answers of pictures showing Fear with eyebrows and without eyebrows ( $t(29) = 1.48, p = .150$ ).

A paired samples t-test showed no significant difference between the percentage of correct answers of pictures showing Happiness with eyebrows and without eyebrows ( $t(29) = 0.85, p = .403$ ).

*Reaction time*

Table 2 presents the means and standard deviation of the reaction time per question and per condition in milliseconds.

Table 2. Average reaction time per condition in milliseconds ( $n = 30$ ) ( $M$  = mean,  $SD$  = standard deviation).

Pictures	$M$	$SD$
Fear	2237.20	920.11
Happiness	824.73	572.37
Without eyebrows	1583.33	704.10
With eyebrows	1499.87	632.13
Fear with eyebrows	2340.89	1076.14
Fear without eyebrows	2204.40	1045.37
Happiness with eyebrows	854.13	612.61
Happiness without eyebrows	795.33	617.02

A paired samples t-test showed a significant difference between the average reaction time of pictures showing happiness compared to pictures showing fear ( $t(29) = 8.81, p < .001$ ). The reaction time of participants for pictures showing Happiness ( $M = 824.73, SD = 572.37$ ) is lower compared to reaction time of participants for pictures showing Fear ( $M = 2237.20, SD = 920.11$ ).

A paired samples t-test showed no significant difference between the reaction time of pictures of people without eyebrows compared to people with eyebrows ( $t(29) = 0.87, p = .389$ ).

A paired samples t-test showed no significant difference between the reaction time of pictures of people showing Fear with eyebrows when compared to pictures of people showing Fear without eyebrows ( $t(29) = 0.66, p = .515$ ).

A paired samples t-test showed no significant difference between the reaction time of pictures of people showing Happiness with eyebrows when compared to pictures of people showing Happiness without eyebrows ( $t(29) = 0.72, p = .479$ ).

## **Conclusion and Discussion**

### *Discussion*

The initial objective of the experiment was to identify the influence of eyebrows on the recognition of emotions happiness and fear. It was expected, as mentioned in H1, that participants would not easily be able to recognise the emotion showed in the pictures without eyebrows. The results, however, did not detect any significant difference in recognition of the emotions for either pictures with or without eyebrows on both accuracy and reaction time. H1 can thus be discarded. A possible explanation for this might be that participants were unable to see the differences between the pictures with and without eyebrows. This may be the case, because participants were exposed to the pictures for only a very short amount of time.

It was hypothesised in H2 that the emotion happiness would be recognised more easily compared to fear. The current study found this to be true for both accuracy and reaction time. Happiness was significantly more recognised than fear. Happiness was also recognised significantly faster than fear. This may mean that the visual cues for happiness shortened the thinking process of the participants. The shorter reaction time when looking at a picture depicting happiness may also be explained by the fact that there was no other positive emotion available as an answer. After all, fear had to compete with two other negative emotions.

This finding is in line with the findings of Ekman (1977), Ekman and Friesen (1971), and Ekman et. al (1972) who mention in their studies that happiness is the emotion that is easiest to recognise. Fear was recognised less compared to the results found by Ekman (2016), who mentioned in his study that fear was recognised between 75-100 percent. This may have been the case, because the participants were influenced by the other answer choices and did not want to answer the question with the same answer every time. Another possible explanation for this might be in line with the findings of Schachter and Singer (1962) who found that specific emotions cannot be concluded from facial features only.

### *Limitations*

One of the possible limitations for this study might have been the setting of the experiment. The researcher let students take part in the experiment in a public space. This may have caused the participants to be distracted, which could have intervened with the answer choices and reaction time of the participants.



The amount of participants might be too small for this experiment, which means the population used in this study may not adequately reflect the total human population. This could influence the generalizability of the findings or conclusion. The participants were mostly female, which does not give a general conclusion among the population. The results can thus not be generalised over the entire population. The participants all reported to have a higher educational level, while a larger amount of the population does not.

#### *Future Research*

It is, however, still interesting to do an additional experiment similar to this with more participants. In future research this experiment could be repeated with more participants to increase the validity of the results. Another suggestion for further research, is to let participants take part in the experiment in a controlled setting to decrease the distractions and interferences. This may lower the time it takes for participants to answer the question. It would also be interesting to assess the effects of other facial features on the recognition of emotions. For example, leaving out the nose or the mouth.

#### *Conclusion*

The results of this study show that the absence of eyebrows does not influence the recognition of the emotions happiness and fear. The challenge now is to see if this is the case for other emotions or other facial features. This study adds to the current knowledge on emotional research, by investigating the influence of specific facial features on the recognition of emotions that may be of influence during a social interaction.

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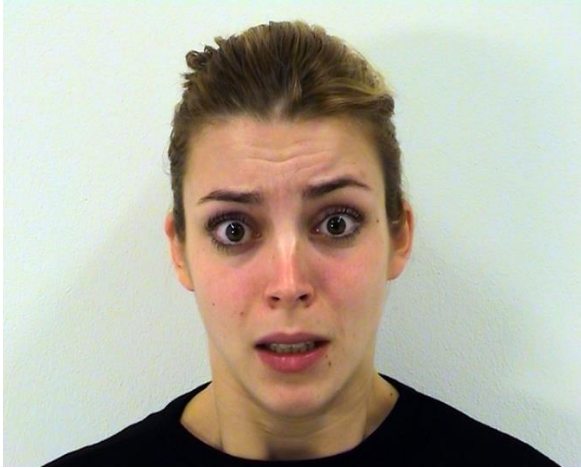
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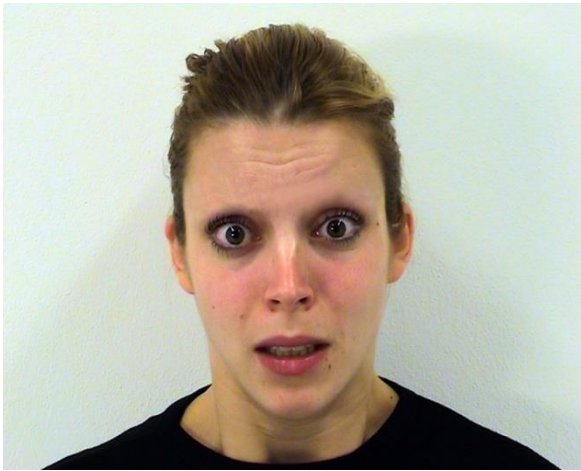
**Appendix 1.**



1. Fear with eyebrows



2. Happiness with eyebrows



3. Fear without eyebrows



4. Happiness without eyebrows