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**Facial Expression Recognition**

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**Project Report**

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**Introduction**

Trying to interpret a person's emotional state in a nonverbal form, usually requires decoding his/hers facial expression. Many times, body languages and especially facial expressions, tell us more than words about one's state of mind.

For this project I have performed an experiment which serves multiple purposes:

1. Finding out, once and for all, who "reads" facial expressions better- Men or Women, and if so, suggesting an answer for the question- why do those differences exist?
2. Revealing special features for recognizing classically defined facial expressions and answering the question- which facial cues help us the most decipher facial expressions?

Moreover, I will try to justify those features from an evolutionary point of view.

**The Importance of Facial Recognition**

Understanding the human facial expressions and the study of expressions has many aspects, from computer analysis, emotion recognition, lie detectors, airport security, nonverbal communication and even the role of expressions in art.

Improving the skills of reading expressions is an important step towards successful relations.

**Expressions and Emotions**

A facial expression is a gesture executed with the facial muscles, which convey the emotional state of the subject to observers. An expression sends a message about a person's internal feeling. In Hebrew, the word for "face"- פָּנִים, has the same letters as the word represents "within" or "inside"- פְּנִים. That similarity implies about the facial expression most important role- being a channel of nonverbal communication.

Facial expressions are a primary means of conveying nonverbal information among humans, though many animal species display facial expressions too.

Although human developed a very wide range and powerful of verbal languages, facial expression role in interactions remains essential, and sometimes even critical.

Expressions and emotions go hand in hand, i.e. special combinations of face muscular actions reflect a particular emotion. For certain emotions, it is very hard, and maybe even impossible, to avoid it's fitting facial expression.

For example, a person who is trying to ignore his boss's annoying offensive comment by keeping a neutral expression might nevertheless show a brief expression of anger. This phenomenon of a brief, involuntary [facial expression](http://en.wikipedia.org/wiki/Facial_expression) shown on the face of humans according to emotions experienced is called 'microexpression'.

Microexpressions express the seven universal emotions: **happiness, sadness, anger, surprise, contempt, fear** and **disgust**. However, Paul Ekman, a Jewish American psychologist who was a pioneer in the study of emotions and their relation to facial expressions, expanded the list of classical emotions. Ekman has added to the list of emotions nine more: **amusement, shame, embarrassment, excitement, pride, guilt, relief, satisfaction and pleasure.**

Microexpression is lasting only 1/25-1/15 of a second. Nonetheless, capturing it can illuminate one's real feelings, whether he wants it or not. That is exactly what Paul Ekman did.

Back in the 80's, Ekman was already known as a specialist for study of facial expressions, when approached by a psychiatrist, asking if Ekman has the ability to detect liars. The psychiatrist wanted to detect if a patient is lying by threatening to suicide. Ekman watched a tape of a patient over and over again, looking for a clue until he found a split second of desperation, meaning that the patient's threat wasn't empty. Since then, Ekman have found those critical split seconds in almost every liar's documentation. The leading character in the TV series "Lie to me" is based on Paul Ekman himself, the man who dedicated his life to read people's expressions- the "human polygraph".

The research of facial expressions and emotions began many years before Ekman's work. Charles Darwin published his book, called "The Expression of the Emotions in Man and Animals" in 1872. This book was dedicated to nonverbal patterns in humans and animals and to the source of expressions.

Darwin's two former books- "The Descent of Man, and Selection in Relation to Sex" and "[On the Origin of Species](http://en.wikipedia.org/wiki/On_the_Origin_of_Species)" represented the idea that man did not came into existence in his present condition, but in a gradual process- Evolution.

This was, of course, a revolutionary theory since in the middle of the 19th century no one believed that man and animal "obey to the same rules of nature".

Darwin's work attempted to find parallels between behaviors and expressions in animals and humans. Ekman's work supports Darwin's theory about universality of facial expressions, even across cultures.

The main idea of "The Expression of the Emotions in Man and Animals" is that the source of nonverbal expressions of man and animals is **functional**, and not communicative, as we may have thought. This means that facial expressions creation was not for communication purposes, but for something else.

An important observation was that individuals who were born blind had similar facial expressions to individuals who were born with the ability to see.

This observation was intended to contradict Sir Charles Bell's idea (a Scottish surgeon, [anatomist](http://en.wikipedia.org/wiki/Anatomist), [neurologist](http://en.wikipedia.org/wiki/Neurologist) and [philosophical theologian](http://en.wikipedia.org/wiki/Philosophical_theologian), who influenced Darwin's work), who claimed that human facial muscles were created to provide humans the unique option to express emotions, meaning, for communicational reasons.

According to Darwin, there are three "chief principles", which are three general principles of expression:

1. The first one is called "principle of serviceable habits". He described it as a habit that was reinforced at the beginning and then inherited by offspring.

For example: he noticed a serviceable habit of raising the eyebrows in order to increase the vision field. He connected it to a person who is trying to remember something, while performing those actions, as though he could "see" what he is trying to remember.

1. The second principle is called "antithesis". Darwin suggested that some actions or habits might not be serviceable themselves, but carried out only because they are opposite in nature to a serviceable habit.

I have found this principle very interesting, and I will go into more detail later on.

1. The third principle is called "The principle of actions due to the constitution of the Nervous System". This principle is independent from will or a certain extent of habit. For example: Darwin noticed that animals rarely make noises, but in special circumstances, like fear or pain they response by making involuntary noises.

**The "Antithesis" Principle**

As I mentioned earlier, the antithesis phenomenon refers to the way that some muscle movements represent an emotion, and the opposite muscle movements represent the opposite emotion.

An impressive explanation for the facial expression represents 'helplessness' can be done using antithesis:

Helplessness body gesture involves hands spreading to the sides, fingers spreading and shoulders shrugging. It's facial expressions involves pulling down the bottom lip and raising eyebrows, like you can see in the followed image:



Darwin explained the features of this expression using the antithesis principle. He discovered that all of those movements opposing to the movements of a man who is ready to face something. The movements of a person who is preparing himself for something will look like that: closed hands and fingers (as if he is preparing for a fight, for example), hands close to the body for protection and the neck is raised and tight. At a helplessness situation the shrugging of the shoulders releases the neck.

As for the face: eyebrows are low (like in a mode of attack or firmness), upper lip might reveal teeth.

The functional source of the antithesis can be explained with the investigation of muscles, and to be precise- the antagonist's muscles. Every muscle has an antagonist muscle that performs the opposite movement. Spreading fingers is a movement done by some muscles, and closing the fingers is done by the antagonist muscles. For some expressions we can't always tell just by looking at it, what is the opposite expression, but if we'll look at the muscles involving in the process then it becomes very clear

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An interesting explanation to the antithesis functional source relies on inhibition.

If a person or an animal is trying to prevent itself doing a particular action, one way is to use the antagonistic muscles. In fact, when a stimuli signal is send to a muscle, an inhibitory signal is send automatically to the antagonist muscle. Facial expressions that can be explained with antithesis usually relates to aggression and avoiding it.

**Facial Expressions Evolutionary Reasons**

A common assumption is that facial expressions initially served a functional role and not a communicative one. I will try to justify each one of the seven classical expressions with its functional initially role:

1. **Anger:** involves three main features- teeth revealing, eyebrows down and inner side tightening, squinting eyes. The function is clear- preparing for attack. The teeth are ready to bite and threaten enemies, eyes and eyebrows squinting to protect the eyes, but not closing entirely in order to see the enemy.

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1. **Disgust:** involves wrinkled nose and mouth. Sometimes even involves tongue coming out.

This expression mimics a person that tasted bad food and wants to spit it out, or smelling foul smell.



1. **Fear:** involves widened eyes and sometimes open mouth.

The function- opening the eyes so wide is suppose to help increasing the visual field (though studies show that it doesn't actually do so) and the fast eye movement, which can assist finding threats. Opening the mouth enables to breath quietly and by that not being revealed by the enemy.



1. **Surprise:** very similar to the expression of fear.

Maybe because a surprising situation can frighten us for a brief moment, and then it depends whether the surprise is a good or a bad one. Therefore the function is similar.

1. **Sadness:** involves a slight pulling down of lip corners, inner side of eyebrows is rising. Darwin explained this expression by suppressing the will to cry. The control over the upper lip is greater than the control over the lower lip, and so the lower lip drops. When a person screams during a cry, the eyes are closed in order to protect them from blood pressure that accumulates in the face. So, when we have the urge to cry and we want to stop it, the eyebrows are rising to prevent the eyes from closing.

1. **Contempt:** involves lip corner to rise only on one side of the face. Sometimes only one eyebrow rises. This expression might look like half surprise, half happiness.

This can imply the person who receives this look that we are surprised by what he said or did (not in a good way) and that we are amused by it. This is obviously an offensive expression that leaves the impression that a person is superior to another person.



1. **Happiness:** usually involves a smile- both corner of the mouth rising, the eyes are squinting and wrinkles appear at eyes corners. The initial functional role of the smile, which represents happiness, remains a mystery. Some biologists believe that smile was initially a sign of fear. Monkeys and apes clenched teeth in order to show predators that they are harmless. A smile encourages the brain to release endorphins that assist lessening pain and resemble a feeling of well being.

Those good feeling that one smile can produce can help dealing with the fear. A smile can also produce positive feelings for someone who is witness to the smile, and might even get him to smile too.

Newborn babies have been observed to smile involuntarily, or without any external stimuli while they are sleeping. A baby's smile helps his parents to connect with him and get attached to him. It makes sense that for evolutionary reasons, an involuntary smile of a baby helps creating positive feelings for the parents, so they wouldn't abandon their offspring.

**Approach and Method**

**Experiment Description**

My experiment has been composed from 2 sections:

First, a series of 35 full facial images, each representing one of the seven different facial expressions, is presented to each participant. Each picture appears for 4 seconds only, followed by a black screen, in order to prevent the participant adapt to the image. The participant labels each picture as one of the seven given facial expressions and fills in a given form, made for this purpose, during the "black screen".

The participant also needs to fill in which 1-3 facial features assisted him/her to classify the image as is.

Second, a series of 21 facial features images is presented to each participant, again for 4 seconds only. The participant classifies each feature to a facial expression and fills in the form, during the "black screen". The purpose of the second part was to see if a person can identify expressions better or worse using only some facial parts and also to see if the time for recognition changes.

20 men and 20 women took part in my experiment.

**My Assumption**

It's no secret that women considered to be more intuitive than men.

More often, women considered to be more compassioned and emphatic to their surroundings. Therefore, the gift of interpreting facial expressions is related usually to women. I believe that my experiment results will support this assumption.

**Experiment Results**

I have analyzed each of the seven facial expressions, and compared the success percentage of men and women in each part of the experiment.

As we can see in the graph, women and men identified happiness in similar percentages. The most interesting part, in my opinion, is that happiness was identified in almost 100% success. My assumption is that happiness, being a positive emotion, is a mood that people wants to be around. Happy people project their feelings to others and help to create good vibes in their surroundings. It is important to recognize easily this kind of emotion because it is helpful to be around. Maybe this is the reason for easy identification of happiness.

The graph shows that though women recognized sadness better than men in full facial images, men recognized it better in the facial features images.

This expression was difficult to recognize for both men and women. In the first part of the experiment, most of the mistakes were labeling sadness instead of contempt.

On the other hand, in the second part, most of the mistakes were labeling happiness instead of contempt. I think that the confusion in the second part came from the mouth shape for contempt, which involves lip corner to rise on only one side of the face. Most of the people indicated that the eyebrows, along with the lips, helped them to recognize the expression.

I believe that the shape of the eyebrows got people to confuse contempt with sadness in the first part. This expression is a tricky one, and I have expected confusions in its identification.

Surprisingly, this expression was recognized better by men.

Those three expressions- Fear, Disgust and Anger, were recognized better by women, and we can see that most of the times the difference in percentage of success between men and women are significant.

An interesting question that should be asked is- why are those specific emotions were recognized better by women?

From an evolutionary point of view, evolutionary psychologists have suggested that females, due to their role as primary caretakers, are "programmed" to accurately decode and detect distress in preverbal infants or threatening signals from other adults to enhance their chances to survive. Fear, anger and disgust are indeed situations of distress.

The most common two special features that helped the participants to decode the expression and the emotion behind it were the lips and the eyebrows. I have also found out that most of the times, in the second part of the experiment, the recognition took less than 4 seconds. This means that there are special features for each emotion, and if we focus on that features alone we will be able to decode the expression faster.

**Conclusions**

I have analyzed men and women results for all the seven emotions and those are the final results:

The final result shows that women do decode expression better in both parts of the experiment, though the difference between sexes was very small in the second part of the experiment.

Are women natured or nurtured to be different? That is still a mystery and an interesting lead to follow.

**References**

Here is the list of information sources which I have used while working on the project and writing the documentation:

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