

# Gender Difference in Facial Imitation.

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### Abstract

Facial expressions reveal emotion, and imitation of these expressions gives the imitator and understanding of how others feel. Are there gender differences in imitation of facial expressions? 61 male and female students participated in this study, where facial imitation was measured. The smiling (zygomatic) and frowning (corrugator) muscle was measured with EMG, as the participants viewed happy and angry faces. A significant result was found between gender, muscle and stimuli at the longest exposure time (2350 ms). This result showed that females responded with increased activity in the zygomatic muscle when viewing happy faces and more corrugator activity when viewing angry faces. The male participants on the other hand had more zygomatic activity (smiling) when viewing both happy and angry faces.

### Gender difference in facial imitation.

We show the world how we feel in very many ways. We can explicitly say it, in words, or we can show it through so called non-verbal cues. One definition by Stewart, Stewart, Fridely and Cooper (Kulich, 1994), says that non-verbal communication is all communication, except communication that consist of words. That is non- verbal communication is posture, gesture, eye contact, and facial expressions. Even though this definition does not include characteristics of the voice, i.e. tone of voice, pitch, and pauses, this is often included in the definition of non-verbal communication. Facial expressions, and other non-verbal communication, functions as cues that "...most often reveal our emotions, our attitudes, our personalities, or the nature of our relationships with others" (Kulich, 1994, p. 3). They guide communication. However they can not alone give another person the understanding of how one feels. The other person has to interpret you expressions, decode it. These non-verbal cues are thus important in the process leading to an empathic understanding of other persons.

Empathy has several definitions. The Penguin dictionary of Psychology defines it as: a/ "A cognitive understanding of the emotions and feelings of another person. In this sense the term's primary connotation is that of an intellectual or conceptual grasping of the affect of another." and b/ " A vicarious affective response to the emotional experience of another person that mirrors or mimics that emotion. In this sense there is the clear implication that an empathic experience is a sharing of the emotion with the other person" (Reber, 1995, p. 249). There is no single definition that is accepted in the psychological world, but there is an agreement that empathy involves experiencing the affect or psychological state of another person (Sonnyby- Borgström, 2002), or as Cloninger (2000, p. 119) writes, "empathy refers to awareness and sensitivity to another person's feelings". Hoffman (in Davis, 1994) has suggested six modes through which a person reacts to others, the second one he calls mimicry.

This process happens when a person imitates, often unconsciously, the other person. This imitation may be of facial expressions or postures (Davis, 1994). The above mentioned definitions and the second mode of Hoffman (in Davis, 1994), are an emotional or affective side of empathy. The emotional and affective modes are more used than Hoffman's sixth mode that involves more cognitive processing. This mode, called role taking, involves deliberate effort to imagine how one would react, facing what the other person is facing (Davis, 1994). Because empathy often is defined in only one way, that is includes only one aspect of empathy (i.e. the cognitive aspect), several questionnaires has been developed. The Questionnaire Measure of Emotional Empathy (QMEE), measures the emotional responses to others experiences, whereas the Hogan Empathy Scale (HES), measures the cognitive response, to name a few of the empathy questionnaires available (Cliffordson, 2002).

Emotional contagion has been implicated as a part of empathy (Sonnby-Borgström, 2002). As explained by Hatfield, quoted in Sonnby-Borgström (2002, p. 31.), emotional contagion is “ the tendency to automatically mimic and synchronise facial expressions, vocalisations, postures, and movements with those of another person and consequently to converge emotionally”. Emotional contagion is a complex process that involves both conscious perception and automatic, unintentional mechanisms, that are not accessible to awareness (Wild et al., 2001). Wild et al. (2001) explain the perception of facial expressions as a three-stage process of emotional contagion; “...Facial expressions triggers facial mimicry which in turn causes afferent feedback from facial receptors or neural structures involved in facial movements, thus evokes emotions” (Wild et al., 2001, p. 110). The theory of facial feedback (Pinel, 2000; Sonnby-Borgström, 2002), is a part of the three-stage explanation of facial contagion, presented in Wild et al. (2001). Facial feedback appears when facial expressions, that is facial muscle activity, influences the emotions experienced, via feedback. Thus, if you smile, you will feel happy, and if you frown, you'll feel angry. To

understand and share the feeling, the interpreter imitates the facial expression of the sender. The imitation of the facial expression elicits a feeling that is similar to the sender, and therefore one understands what the sender feels. Tomkins has a similar view of facial expressions. That is, he believes that the facial expressions give an emotional experience, feeling, via proprioceptive perceptual feedback (Sonnby-Bergström, 2002). Another theory of how people understand others, is the theory of mind, a developmental psychology expression. It refers to “the ability to make inference about others’ mental states, such as intentions, feelings, beliefs or focus of attention” (Stone et al., 2003, 210).

The imitation of facial expressions, are thought to be unconscious, the person that imitates is not aware of this imitation. This means that the imitation happens very fast, and that the muscle reactions are spontaneous and out of the person's control. But if given enough time, the initial spontaneous response can be overridden and altered. The term Duchenne smile, refers to the true smile (Pinel, 2000). This genuine smile involves a special facial muscle, which makes it possible to separate from a false smile. The difference is the muscles around the eye, orbicularis oculi, when the smile is true, these muscles contract. The zygomatic muscle, smiling muscle, that pulls the lips corners up, are contracted in both the true and false smile (Pinel, 2000). When confronted with a sad or maybe angry facial expression, the initial imitation response of facial imitation can be overridden and a false smile may be produced. This is why several studies have chosen exposure times (i.e. 6 s and 2350 ms) of various lengths (Dimberg, 1981; Dimberg & Lundquist, 1989; Sonnby-Borgström, 2002; Wild et al., 2001). The present study operates with three exposure times, 17ms, 56 ms and 2350 ms. These were chosen to see if there are differences at exposure times that elicit spontaneous reactions, that is where the subjects are not exposed to the stimuli long enough to alter their response (Sonnby-Borgström, 2002). It is thought that the shorter exposure times, that is 17 ms (preattentive level) and 56 ms (automatic level), involves more primary memory

process and subcortical structures, whereas the longest exposure time, called controlled level, involves secondary memory systems (Sonnby-Borgström, 2002).

It has been found in studies by Dimberg (1981) that people tends to imitate facial expressions. Pictures of happy and angry faces elicited different muscle responses in the participants in his experiment. Happy faces tended to elicit activity in the zygomatic muscles (smiling muscle) and angry faces tended to elicit activity in the corrugator muscle (frowning muscle). The hypothesis of emotional contagion has been supported by the results obtained in studies by Sonnby-Borgström (2002). Individuals high in empathic ability showed in these studies a higher degree of imitation of facial expression than individuals low in empathic ability. Based on the score on an empathy scale, measuring the emotional component of empathy (QMEE), the participants were divided into two groups, low empathy and high empathy. The high-empathy group imitated the facial expressions more than the low empathy groups. These mimicry reactions occurred already at very short exposure times (17-56 ms), a support of automatic mimicry reactions (Sonnby-Borgström, 2002). The participants had no possibility to control the facial muscle reactions at such short exposure times. An interaction between self-reported feelings, facial muscle reactions and empathic ability was also found in these studies. The high-empathy group smiled more, when reporting positive emotions, and smiled less, when reporting negative emotions. The low-empathy group on the other hand, smiled more when reporting negative emotions than when they reported positive emotions (Sonnby-Borgström, 2002).

The imitation of facial expressions or actions may rely on a specific neural network, mirror neurones (Tessari et al., 2002). These mirror neurones were found in monkeys, but there are similar reactions in the human brain, when imitating or observing actions. This system, of mirror neurones, is assumed to have two functions. One is to understand the action or the goal of others. The second one is to copy (imitate) the other, and this function is very

important in learning (Tessari et al., 2002). Infants imitates facial expressions early, they try to copy an expression even though they are not fully capable to do so. Infants may protrude their tongue and turn their head to one side, to copy the tongue protrusion to the right corner of the mouth shown by an adult (Meltzoff & Moore, 1997). This imitation of facial expressions helps the infants learning, and can be linked to the second function of the mirror system.

When asserting the emotional valence of a stimulus, the fusiform gyrus, anterior temporal lobe and inferior medial prefrontal cortex area of the brain are involved (Geday et al., 2003). The prefrontal cortex is possibly involved in both the experience and the expressions of emotions by certain motor pathways (Banich, 1997). Other evidence to the role of frontal lobe in emotion, is that fact that prefrontal lobotomy has the effect of emotional blunting, and that frontal cortical damage reduce the expression of emotion (Pinel, 2000). The amygdala is another area, that when damaged impairs recognition of emotional expressions (Iidaka et al, 2001, Stone et al, 2003). The amygdala is a part of the limbic system, that is a subcortical neural system, located in the middle of the brain, important for emotion (Banich, 1997). The amygdala has been found to be active during tasks with emotional faces, and this area is thought to interact with prefrontal (part of frontal lobe, see above) and temporal cortices. (Iidaka et al, 2001). The amygdala has also been linked to theory of mind, because children with autism, that has amygdala abnormalities, have problems with theory of mind (Stone et al, 2003).

Darwin (in Kulich, 1994) claimed that females, from birth, are better to interpret non-verbal cues, whereas Hall (in Kulich, 1994) claimed that it is social learning that gives females this advantage. A study by Dimberg and Lundquist supported that females are more facially expressive and score higher in non-verbal receiving abilities than males ( Dimberg & Lundquist, 1989). Dimberg and Lundquist (1989) found that females reacted with more facial

muscle activity than males, when exposed to different facial stimuli. Males did not differ in corrugator and zygomatic activity, when viewing angry and happy faces. Women are also found to be clearer encoders, that is “sending” non-verbal information, as well as better decoders, interpreting non-verbal information (Argyle & Colman, 1999). Thayer and Johnsen (2000) found, in a study where the participants classified emotions of facial expressions based on self-reported ratings, that females are better at recognising emotional expressions correctly, than males. They also found that males and females not only differed in decoding the emotion of facial expressions, but that there also was a gender difference in the mistakes they made when classifying emotion. Males had problems distinguishing between emotions, whereas Females did not have that problem. The mistakes females did, was in distinguishing between male and female faces with the same emotional expression (Thayer & Johnsen, 2000). Thus, men did not see the difference between sad and disgusted, and females did not discriminate between males with happy faces, and females with the same expression. Cloninger (2000) suggested that females might be better decoders of non-verbal information because they are more empathic than males. They might understand other person’s feelings and emotions because of a higher degree of empathy. The findings in Sonnby-Borgsöm’s (2002) study support that notion. The findings suggest that mimicry, that is imitation, give empathy. Thus, because non-verbal cues are interpreted, to some extent, through imitation, the larger understanding of others, that is a part of the empathy definition, is caused because of more imitation (Sonnby-Borgström, 2002). Empathy might be the result of imitation, or imitation a result of empathy. Even though several studies have found that females are more empathic, other studies have not been able to replicate those findings. The definition of empathy, effects the findings. When empathy is defined to be role-taking (mode six) there are no gender differences found, but when empathy is defined as emotional responsiveness females score higher than males (Davis, 1994).



The main aim of the present study, based on data collected by Sonnby-Borgstöm, was to examine gender differences in facial imitation, when viewing happy and angry faces. Empathy, as emotional responsiveness, will also be examined together with gender and facial muscle activity. As several studies have shown, females are found to be more empathic than males (Cloninger, 2000), they are also found to be more facially responsive than males (Dimberg & Lundquist, 1989). Thus I expect females to imitate facial expressions more than males.

### Method

The present study is based on data collected in a previous experiment (Sonnby-Borgström, 2002). These data was however not analysed with respect to gender. Thus the method is the same as used in Sonnby-Borgström's experiment (2002), but the statistical analyses are different. Because of this the description of the experimental method is not very extensive (for more details see Sonnby-Borgström, 2002).

Sixty-one students (33 males, 29 females) participated in this study, on a volunteer basis (median age 22, range 19-35 years).

Four different male faces with happy or angry facial expression, taken from *Unmasking the Face* by Ekman and Friesen, 1993 (Sonnby-Borgström, 2002), were exposed to the participants. All participants viewed both happy and angry expressions. The stimuli and a masking picture (a non-figurative grey-scale picture) were presented via two tachistoscopes on a half transparent screen (35 x 35 cm). The first expression was either of happy or angry expressions, and the expression that followed was of the opposite expression. To compensate for any possible position effect, the exposure frequencies was balanced (50 % viewed the happy face first, and 50 % the angry face). The participants viewed each picture 10 times at three exposure times (17ms, 56 ms, 2350 ms). These exposure times were chosen to make it

possible to distinguish between reactions at preattentive, automatic and controlled level of processing.

To record and measure the facial muscle reactions, so weak and small that they can not be seen by the naked eye, an electromyography (EMG) was used. The zygomaticus major, the smiling muscle indicated positive affect. Whereas the corrugator muscles, the frowning muscle indicated negative affect. The EMG activity was measured using electrodes.

After the EMG recordings the participants answered the Questionnaire Measure of Emotional Empathy (QMEE), that is a self-report scale that measures the emotional aspects of empathy.

An independent t-test was applied to see if there was any difference between gender and empathy. A mixed ANOVA, with one between and two with-in factors, was used to analyse data further. The between factor was gender, stimuli (happy/angry) and muscle (zygomatic, corrugator) was used as with-in factors. Each exposure level was processed separately. A mixed ANOVA, also here with two with-in factors (muscle and reported feeling) and one between factor (gender), was applied to examine gender difference in the muscle activity when reporting feelings. The viewing order was used as a covariant. The SPSS for Windows 9.0 was used to do the data analyses.

### Results.

The participants were divided into a high-empathy and a low-empathy group based on the median score from the QMEE. High empathy participants scored higher than 53, and low-empathy participants scored lower than 53 (31 high-empathy, 30 low-empathy). The distribution of males and females in the two empathy groups was not even; the females dominated the high-empathy group (21 females and 10 males), whereas the males dominated the low-empathy group (23 males and 7 females). The T-test also showed that there was a significant difference between males and females in emotional empathy ( $t(59) = 4.23, p < .01$ ).

As mentioned above, each level (exposure time) was processed separately, with gender as between factor and muscle and stimuli as within. The Mauchly's test of sphericity was significant for all three exposure times (preattentive, automatic and controlled), and to compensate for this the Greenhouse-Geisser test was applied.

No significant result was found for Stimuli\*Muscle\*Gender at the preattentive ( $F(1,58) = 1,027, p > ,05$ ) nor at the automatic ( $F(1,58) = 1,063, p > ,05$ ) level (see table 1 for all results). The Stimuli\*Muscle\*Gender at the controlled level reached significance at, 05 probability ( $F(1,58) = 6,595$ ). Even when the covariant was taken in account, the result was significant. These result shows that females react with more corrugator and less zygomatic muscle activity when viewing angry faces, as expected (see Figure 1a). Men on the other hand react with more zygomatic activity and slightly more corrugator activity when viewing angry faces (See Figure 1b). The muscle activity plots, where each muscle have a separate plot, are shown in Figure 2 a and 2 b. These plots show how males and females differ in muscle responses to each other at the controlled level. Thus it is the same results as in figure 1 a and 1 b.

When analysing the results regarding the correspondence between "reported feeling" and muscle activity the Mauchly's test of sphericity were, again, significant, and the Greenhouse-Geisser test was chosen. There were no significant results found between Musle\*Feeling\*Gender ( $F(1, 45) = ,918, sig. = ,348, p > ,05$ ), even though the plots show that males have a somewhat unexpected curve (see Figure 3a). There was a loss of participants here, because those who only one or two of the three levels of feelings (negative, neutral or positive) was removed. Males tended to have more muscle activity, both zygomatic and corrugator, when reporting neutral feelings, than negative and positive feelings. The females show the expected curve (see Figure 3b), with more zygomatic and less corrugator activity when reporting positive feelings, and the opposite when reporting negative feelings.

Unfortunately the differences were, as shown above, not large enough to give a significant result.

#### Discussion.

The purpose of this study, was to examine gender differences in imitation of facial expressions. There was no significant difference found between the male and female participants on the two shortest exposure times, preattentive level (17 ms) and automatic level (56 ms). At these rapid exposure times the reactions are supposed to be spontaneous, and the participants may not even be aware of their facial reactions. Thus, they have no chance to alter their reactions, to fit social norms or expectations. At the controlled level, with an exposure time of 2350 ms, the participants can alter, that is override the spontaneous, and automatic response that the stimuli elicits. And it was at this controlled level, a significant difference was found. Males tended to smile more, when viewing angry faces compared to viewing happy faces. Whereas women, as expected, smiled less and frowned more when viewing angry faces compared to viewing smiling faces. Thus, the women showed an imitative reaction.

Darwin and Hall (in Kulich, 1994) represent two different explanation to this facial muscle reaction differences. Darwin (in Kulich, 1994) claimed that females are better, than males, from birth to interpret non-verbal behaviour. That is there are a genetic difference between the genders that give females this advantage. The ability to interpret non-verbal behaviour, i.e. facial expressions, is very important when the children are too young to verbally express what they need or feel. It is also important for the female, the primary caretaker, to be well attuned and respond properly to the child's emotional reactions, because children respond to these cues. Because it is, from natures side, the female that is the primary caretaker, that may explain why females are "pre-wired" to imitate, encode and decode non-

verbal cues better than males. If this explanation is true, the difference found in this study, might reflect genetic differences between males and females. But if genes alone, were responsible for the difference, there probably should have been a difference even at the preattentive and automatic level. The results found at the controlled level (see figure 1 a, b and 2a,b), males smile at angry faces, are present even at preattentive and automatic level, but the differences are unfortunately not significant. But because of the similarity with the results at the controlled level, genes can not be ruled out as explanatory factor.

Hall (in Kulich, 1994) claims that the difference in non-verbal abilities, are socially learned abilities. That is, boys and girls learn different things, when growing up, the society shapes their abilities. Females learn more non-verbal skills, both encoding and decoding abilities, and that is why they are superior to males in non-verbal abilities. In this study males and females differed at the controlled level, maybe because the male participants altered their reactions according to socially learned rules. Ekman and Friesen claims (in Wild et al, 2001) that male and female experience the same feeling, have the same emotion, but behave different because of socially learned display rules. It has been found that infant boys have more negative and more positive emotional expressions than girls (Hetherington & Parke, 1999). Brody (in Hetherington & Parke, 1999) suggests that this difference in emotionality in infancy, leads parents to treat their boys and girls differently. Because infant girls show less emotions than boys, parents may encourage daughters to show more emotions, and parents may even encourage boys to suppress emotions, so that the children will act accordingly to what's socially accepted (Brody, in Hetherington & Parke, 1999). According to this, the findings in this study are due to social learning, where boys repress their natural emotional behaviour, whereas girls are thought to be more emotional because of their "lack" of emotions as infants (Brody in Hetherington & Parke, 1999).

None of these theories may however completely explain the differences found in the present study. It might be a combination of genes and social learning that elicits a gender difference in imitation of facial expressions. It is however, hard to study, and determine if genes or social learning is responsible for the differences.

It has been found that infants do imitate expressions (Meltzoff & Moore, 1997), but is this imitation an empathic reaction or just a way to learn muscle control? It could be interesting to do a longitudinal study, to see if the imitation found in infancy, will diminish through social learning in boys, and remain high in girls. Then one might be able to establish if the difference in non-verbal skills, such as imitation of facial expressions, is due to genes or learning. Maybe this imitation that infants does, is just a mean through which muscle control is learned, and has actually nothing to do with the imitation of facial expressions found in older children and adults.

Another explanation of the imitation of facial expressions, may not be related to the gender at all. When looking at the distribution of males and females in the high- and low-empathy group, there was a dominance for one gender in both groups. Females dominated the high-empathy group, only seven males scored high enough to be placed in this group. The males dominated the low-empathy group. The distribution does supports other findings, that suggests, that females are more empathic (Cloninger, 2000), and empathy predicts facial imitation, as Sonnby-Borgström (2002) found. The differences found here may be due to empathic ability, and not gender. The distribution between high- and low empathy was not even, there was a majority of one gender in both group, and not a 50/50 blend that would be preferred. To rule out the possibility that empathy is responsible for the difference found in this study, a new study should be done, where the low- and high- empathy groups are composed of half male and half female participants (50/50 blend). If there still is a gender difference, than empathy can be ruled out as explanatory factor.

There was no difference found between male and female participants in the correspondence between muscle activity and reported feelings. Even though the curve (see figure 3a, b) is very different for the genders, the results was non-significant. Thayer & Johnson found in their study (2000) that males were not as good as females, to distinguish between emotions. This may be because the males smiled, when they should have frowned and therefore elicited, in them self, through feedback, the “wrong” feeling, and therefore rated the emotion wrong. Maybe this problem extends to the process of “putting the right face on”. Facial expression reflects feelings and emotions. Maybe males have problems interpreting these inner emotions and therefor don’t produce the right expressions to the emotion. This process happens with out the awareness of the person, and might be genetic. This may be an explanation to why males frowned more when reporting neutral feelings, as opposed to negative feelings. There was a little decrease in smiling from neutral to positive feelings, but that decrease is minimal. Have males a problem in the feedback process that elicits facial expressions? Or have they learned not to show emotions in that extent females do? Again the question arises as to whether genes or society are responsible to the gender differences in non-verbal abilities. An area that craves more research, much because of so many contradictory findings. The Nature versus Nurture debate will continue as more research are done in the area of gender differences, but will we ever know if genes or society is responsible?

It would be interesting to do further research on the brain areas active during facial mimicry. Are there perhaps different areas activated in females and males?

The results in this study showed that there was a gender difference in imitation of facial expressions. Females showed responses, as one would expect. That is, they smiled to happy faces, more zygomatic muscle activity, and frowned to angry faces, more corrugator activity. Males on the other hand tended to smile, even if the stimulus was an angry face. This differences was evident at all three exposure times, but only the longest exposure time level

reached significant. At this level the participants had time enough to alter their spontaneous response, and that might be what the male participants did. It might be genetics or socially display rules that elicits this difference between the genders, but in this study it is not possible to rule any of the explanations out. Empathy might be another explanation to the findings here, as mentioned above, it needs more research before one can draw certain conclusions. However this study did find that there was a gender difference, and females did imitate facial expressions more than males, as hypothesised. Because of contradictory findings, there is a need for more research, both with adults and younger participants. The question of why we imitates, or where in the brain this function is located are yet to be answered.

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Tabel 1

Results, Stimuli\*Muscle\*Gender.

Level	F	Sig.
Preattentive	1,027	,315
Automatic	1,063	,307
Controlled	6,595	,013*

\*significant,  $p < ,05$

The results for all exposure times. Only the controlled level has reached significance ( $,013, p < ,05$ ).

Figure Captation.

Figure 1a. Female's reaction plot.

Figure 1b. Male's reaction plot.

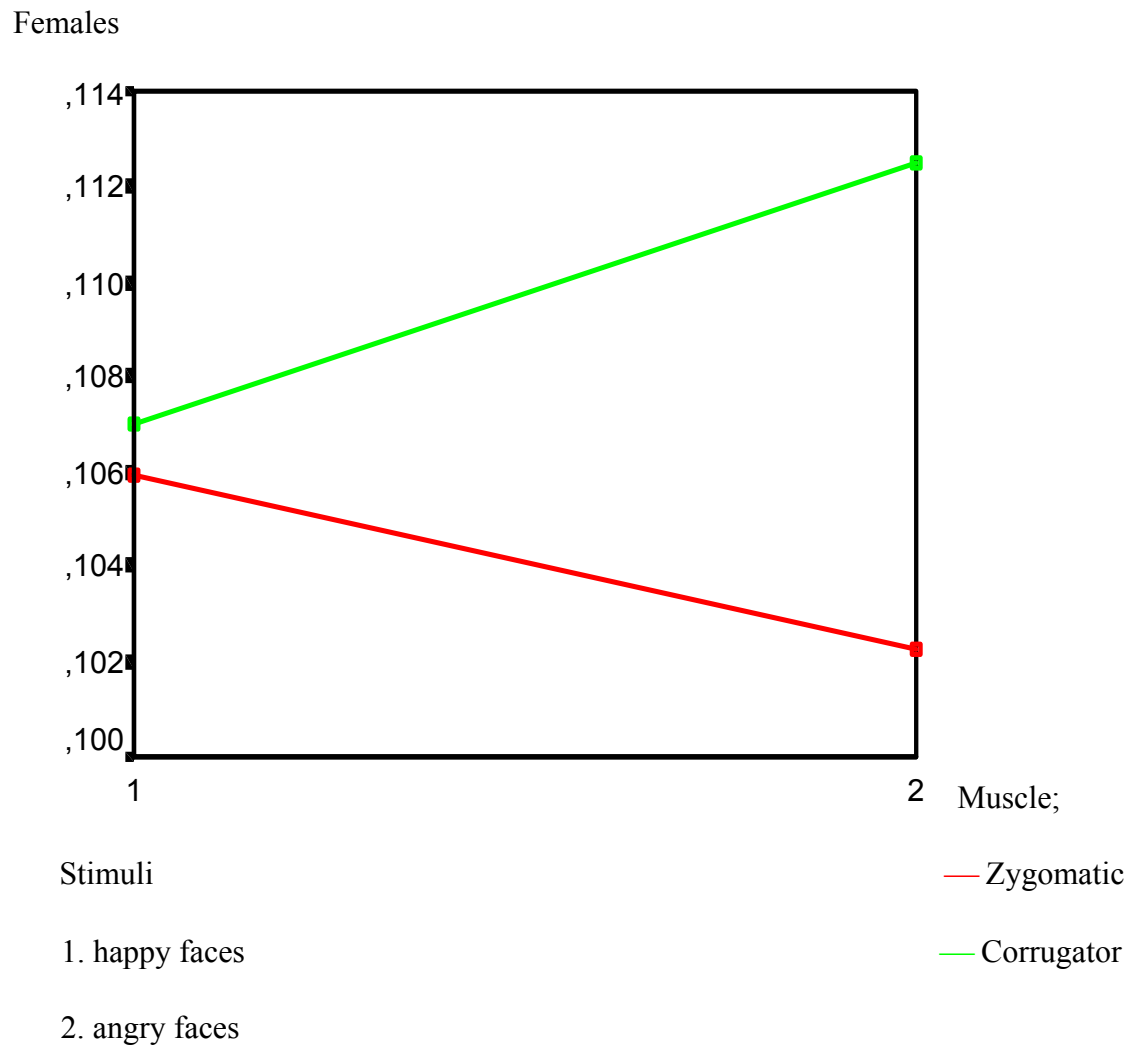
Figure 2a. Zygomatic muscle plot.

Figure 2b. Corrugator muscle plot.

Figure 3a. Females muscle activity plot, when reporting feelings.

Figure 3b. Males muscle activity plot, when reporting feelings.

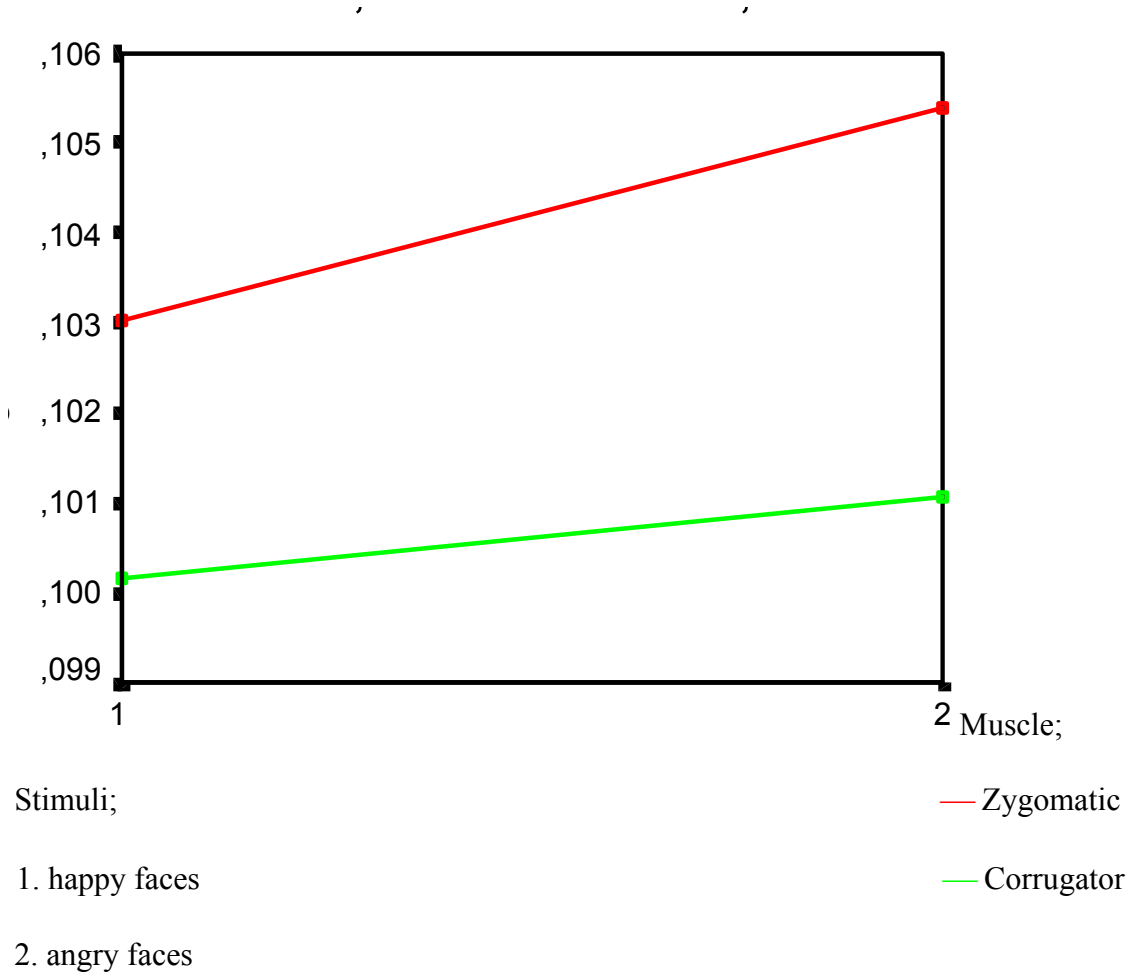
Figure 1a.



The females muscle reaction plot. The zygomatic muscle (smiling) are more activated when viewing happy faces. The Corrugator is more active when viewing angry faces.

Figure 1b.

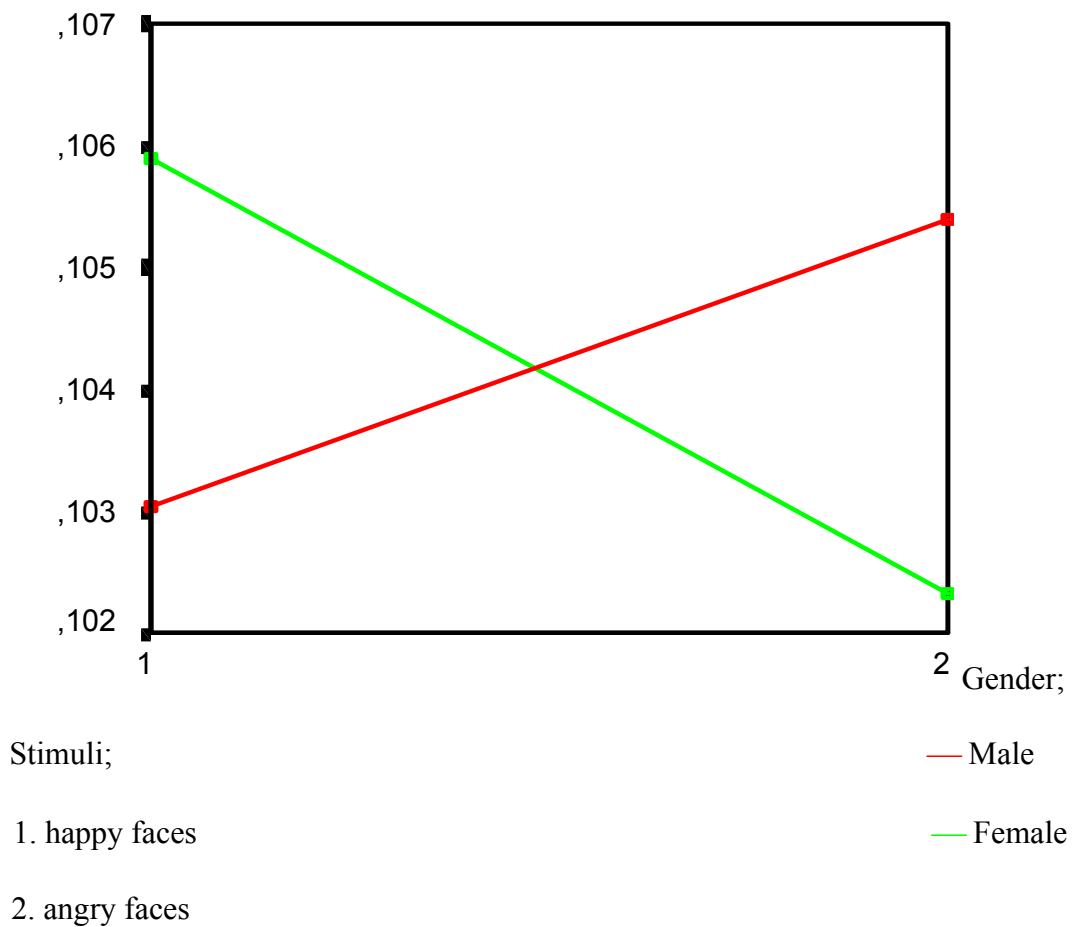
Males



The males muscle activity plot. The opposite reactions found, when comparing with the female participants. The zygomatic muscle (smiling) is more active when viewing angry faces, as are the corrugator muscle, but only a slightly more active as opposed to happy faces.

Figure 2a.

Zygomatic (smiling muscle)

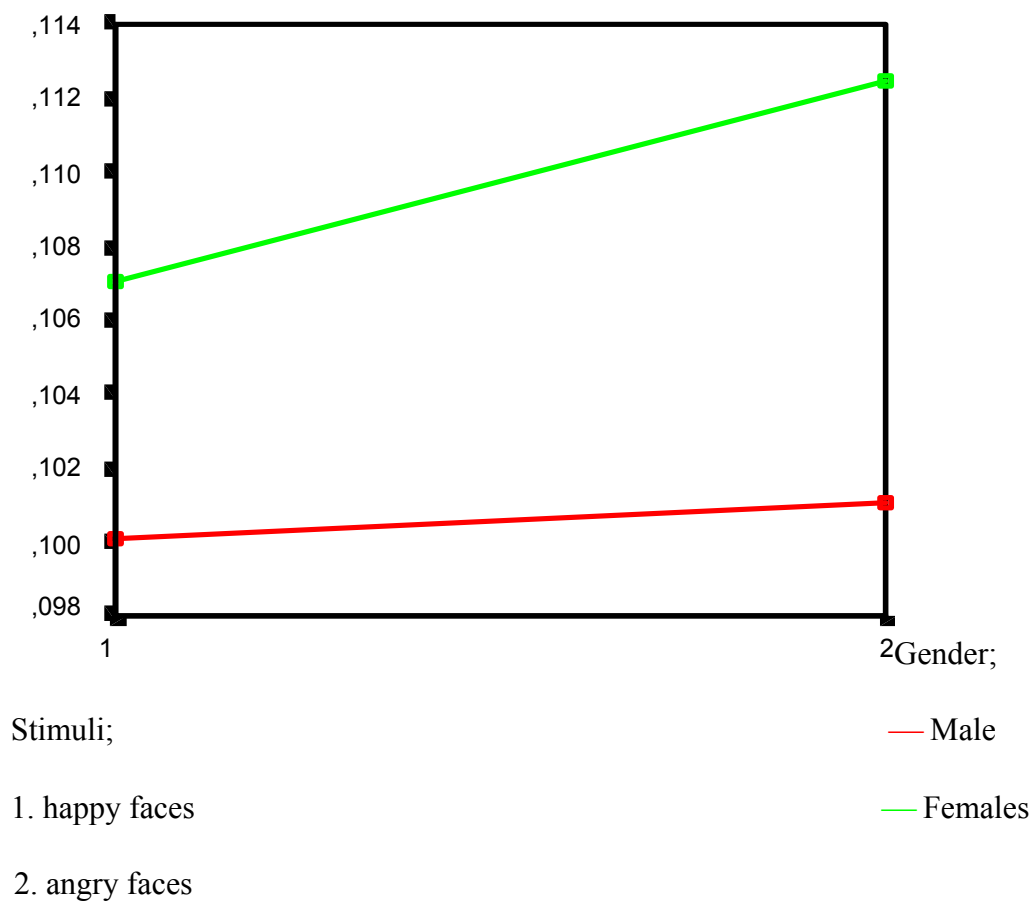


This plot shows how the smiling muscle (zygomatic) activation is for males and females.

Females have the expected curve, smiling, when the stimulus is happy. Whereas males smile when the stimuli is angry.

Figure 2b.

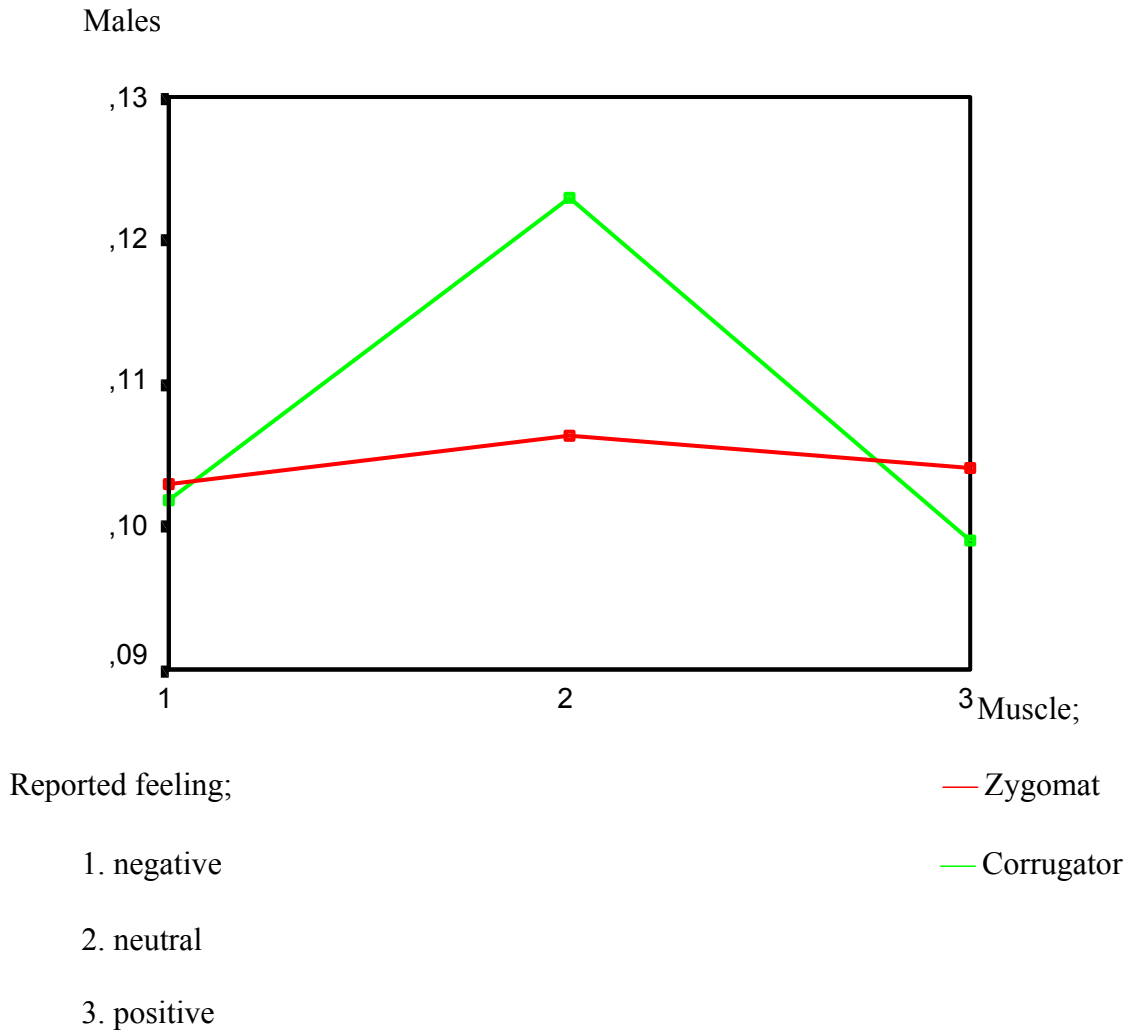
Corrugator (frowning muscle)



The frowning muscle (corrugator) activity plot. Females have a larger activation when viewing angry faces, than happy faces. Males only react with a slight increase in muscle activity.



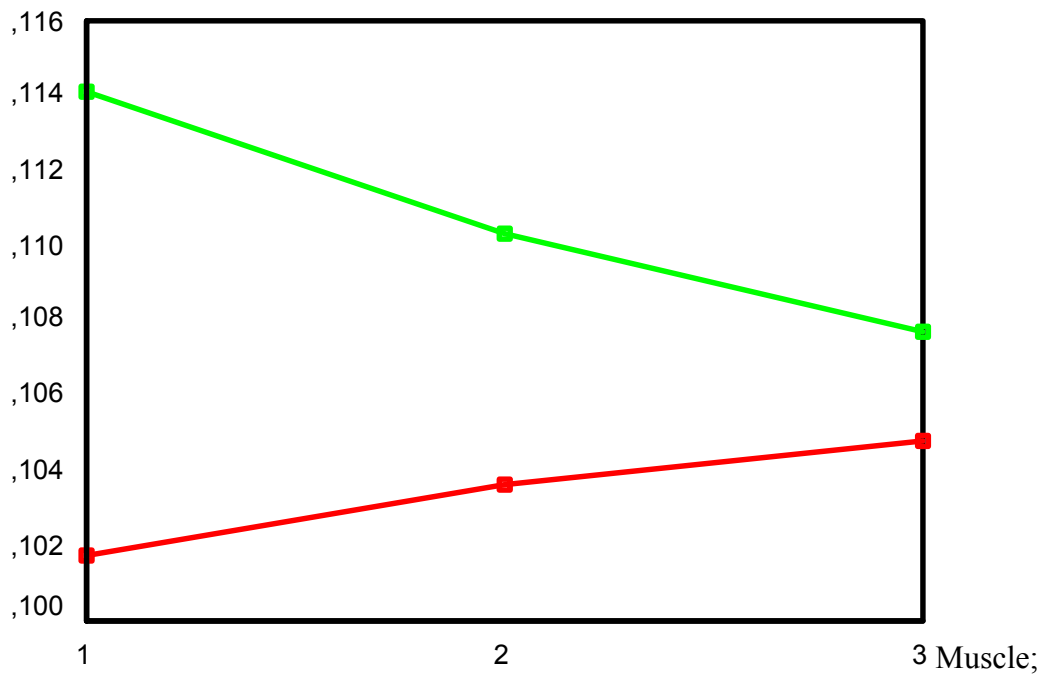
Figure 3a.



Males frown more when reporting neutral feelings, than both positive and negative feelings. They smile (zygomatic) more also when reporting neutral (2) feelings, all though it is only a slight increase from the positive (3) and negative (1) reactions.

Figure 3b.

Females



Reported feeling;

1. negative

2. neutral

3. positive

— Zygomatic

— Corrugator

Females show a decrease in corrugator activity as the reported feelings go from negative to positive. The smiling muscle (zygomatic) shows the opposite curve. As the reported feeling goes from negative (1) to neutral (2) to positive (3), the more active the muscle becomes.