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Facial mimicry is independent of stimulus format: Evidence for facial mimicry of stick figures and photographs☆

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ABSTRACT

The present research investigated facial mimicry of the basic emotions joy, anger, and sadness in response to stimuli in different formats. Specifically, in an electromyography study, 120 participants rated the expressions of joyful, angry, and sad faces presented as photographs or stick figures while facial muscle activity was measured. Using both frequentist and Bayesian approaches to hypothesis testing, we found strong support for a facial mimicry effect: Participants showed higher *zygomaticus major* and *orbicularis oculi* activity (smiling) towards joyful faces, while they showed higher *corrugator supercilii* activity (frowning) towards angry and sad faces. Although participants rated the stick figures as more abstract and less interesting stimuli, the mimicry effect was equally strong and independent of the format in which the faces were presented (photographs or stick figures). Additionally, participants showed enhanced emotion recognition for stick figures compared to photographs, which, however, was unrelated to mimicry. The findings suggest that facial mimicry occurs in response to stimuli varying in their abstractness and might be more robust to social-cognitive influences than previously assumed.

r1. Introduction

> “*That there exists in man a strong tendency to imitation, independently of the conscious will, is certain.*”
>
> Darwin (1872, p. 356)

As Darwin had observed, automatic imitation seems to be a prevalent phenomenon in social interactions (Chartrand & van Baaren, 2009). When it comes to emotional expressions, people frown towards angry and sad expressions (via the *corrugator supercilii* muscle) or raise the lip corners (via *zygomaticus major*) and wrinkle their eyes (via *orbicularis oculi*) in response to others' smiles (Dimberg et al., 2000). Recently, there has been a debate about the automaticity of such mimicry. Although some accounts pleaded for an automatic link between perceiving a nonverbal expression and acting on it (e.g., Chartrand & Bargh, 1999), others pronounced the importance of the social context for facial mimicry to occur (e.g., Hess & Fischer, 2013, 2014). The current research investigated if the richness of the social-cognitive context affects mimicry. Specifically, we tested whether facial mimicry in response to socially rich and ecologically valid photographs differs from facial mimicry in response to more schematic and abstract stick figures.

There is a persuasive amount of research showing the automaticity of imitation in humans (Cracco et al., 2018; Heyes, 2011), presumably mediated via mirror neurons in the brain (Carr et al., 2003). Observing an action facilitates the execution of corresponding action in the observer while inhibiting a non-corresponding action (Cracco et al., 2018). Such stimulus-response compatibility effects also occur during emotional face perception (e.g., Otte, Habel, et al., 2011; Otte, Jost, et al., 2011). For example, participants were instructed to react with a smile or a frown towards faces. The faces exhibited either smiles or frowns. Faster muscle activity onsets can be observed for compatible trials (e.g. when participants should react with a smile to a smiling face) than for incompatible trials (e.g., when participants should react with a smile to a frowning face). Such an effect was found for diverse populations, such as young adults (Otte, Habel, et al., 2011), children with ASD (Schulte-Rüther et al., 2017), and schizophrenic patients (Chechko et al., 2016). These findings suggest that an observed expression automatically activated a common response code for facial expression and thus facilitated the response. Further evidence for automatic processing

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of emotional faces comes from facial mimicry studies. In response to emotional displays, observers' facial muscle reaction starts as fast as 300–400 ms after the onset of a facial emotion stimulus (Dimberg and Thunberg, 1998), even when stimuli are subliminally presented (Dimberg et al., 2000). These slight and fast changes in facial muscle reactions can be captured by facial electromyography (EMG; e.g., Dimberg et al., 2000). Since facial mimicry occurs automatically, as these findings suggest, it may also happen independently of the stimulus format, that is, in response to stick figures and photographs.

However, it has been argued that emotional signals are intrinsically meaningful and therefore not mimicked under every circumstance (Hess & Fischer, 2014). Smiling, joyful displays signal affiliative intentions, while anger expressions rather signal non-affiliative intentions and distancing (Fischer & Manstead, 2008; Hess et al., 2000). Consequently, mimicry of joy is rather independent of social context factors and occurs both in response to joyful ingroup and joyful outgroup members (e.g., Hess & Fischer, 2013). Negative emotions like anger or sadness, in contrast, are sensitive to social distance and rather mimicked for ingroup rather than outgroup members, if mimicked at all (Bourgeois & Hess, 2008; van der Schalk et al., 2011). It seems that the social context plays an important role in mimicry of facial expressions.

Moreover, the dynamics of a facial display affect mimicry. That is, dynamic faces that display a movement from a neutral to an emotional expression are more likely to be mimicked than static faces (e.g., Sato et al., 2008; Sato & Yoshikawa, 2007). Since individuals perceive dynamic faces as more realistic than static faces (Weyers, Mühlberger, Hefele, & Pauli, 2006), dynamic faces represent more intense stimuli, contributing to facial mimicry. This effect occurs especially for happiness but less for anger (Rymarczyk et al., 2011), which may be explained by the stronger context-sensitivity of anger (Bourgeois & Hess, 2008; van der Schalk et al., 2011).

Furthermore, individual characteristics that enhance the sensitivity to the social context—such as high empathy (Rymarczyk et al., 2016; Sonnby-Borgström, 2002) or low autism (Hermans et al., 2009)—also increase facial mimicry.

Together, these lines of research support the idea that a socially rich and meaningful stimulus provokes more facial mimicry than an impoverished stimulus. Consequently, mimicry of facial expressions in photographs may be stronger than mimicry of facial expressions in stick figures. This should be the case because photographs are more realistic and provide a richer affiliative and socially meaningful context than stick figures.

In addition, stick figures can be regarded as more abstract expressions of emotions since they contain the gist of an emotional signal—such as the smile in a smiley face—rather than many details of the displayer (Amit et al., 2012). Thus, stick figures may be mentally construed on a higher level than photographs. Since high-level construal (compared to low-level construal) increases the perceived psychological distance to stimuli (Liberman et al., 2007; Trope and Liberman, 2010), stick figures may be perceived as psychologically more distant than photographs. Since distance reduces imitation of concrete movements or gestures (e.g., Genschow et al., 2019; Hansen et al., 2016; Wessler & Hansen, 2017), the more higher-level construal of stick figures may additionally contribute to a reduced facial mimicry of stick figures compared to photographs.

Using EMG, the present research tested whether mimicry depends on the richness of the social-cognitive context given the stimuli participants reacted to. Participants watched joyful, sad, and angry photographs or stick figures while assessing their facial muscle activity, and participants rated the emotions they had seen. We hypothesized a basic facial mimicry effect, that is, higher zygomaticus and orbicularis compared to corrugator activity towards joyful stimuli and higher corrugator compared to zygomaticus and orbicularis activity towards sad and angry stimuli. Additionally, we tested whether mimicry depends on the format of the emotional stimulus, that is, whether photographs elicit higher levels of facial mimicry than stick figures.

2. Method

2.1. Participants and design

Due to the resource-intensive character of the EMG study, we a priori decided to run a maximum of 120 participants ($n = 60$ per stimulus condition). A sensitivity analysis in G*Power 3.1 (Faul et al., 2007) showed that this sample size allowed to detect effect sizes of $f = 0.15$ or larger with a power of 80% using an alpha level criterion of 0.05 for the test of our key hypotheses in a mixed analysis of variance (ANOVA).

We tested 120 participants (90 females, 30 males) who ranged between 17 and 61 years of age ($M = 24.10$, $SD = 7.67$) and participated for a monetary reward (€7). Participants were randomly assigned to one of two picture format conditions, resulting in a 2 (Picture format: photographs vs. stick figure) × 3 (Emotion: joyful vs. angry vs. sad) × 3 (Muscle site: *zygomaticus major* vs. *orbicularis oculi* vs. *corrugator supercilii*) mixed design, with picture format as between-participants factor and emotion and muscle site as within-participants factors. The study was approved by the ethics committee of the University of Salzburg.[1]

2.2. Procedure

After giving informed consent, the experimenter cleaned participants' skin with Nuprep (Weaver and Company) and 70% alcohol and placed three pairs of TMSi bipolar microelectrodes filled with Signa Gel (Parker Laboratories) on the left side of the face on the *zygomaticus major*, *orbicularis oculi*, and the *corrugator supercilii* muscle sites, following the guidelines of Fridlund and Cacioppo (1986). The raw EMG signal was sampled at 1024 Hz using a TMSi Refa 72 Stationary System and was recorded with TMSi Polybench software. Next, participants engaged in an imagination task for 3 min (see Footnote 1), after which an emotion recognition task started automatically. During each trial, a fixation cross appeared for 4 s, followed by an emotional stimulus for 7 s (see Fig. 1). Participants rated how intense the stimulus had expressed each of six basic emotions (anger, joy, fear, sadness, disgust, surprise) on seven-point scales from 0 ("*not at all*") to 6 ("*very intensively*"). Overall, 12 facial stimuli (four joyful, four angry, four sad; two female and two male models each) were presented, which were either photographs from the NimStim database converted to black and white (i.e., models #05, #10, #27, and #36; Tottenham et al., 2009) or self-drawn stick figures (similar to those used by Hess et al., 2016; see Appendix A, Fig. A1).

Next, participants were exemplarily presented with the four joyful stimuli as samples for the categories of stick figures and photographs. Participants rated the concreteness of the stimuli on five items (e.g., realistic, schematic [reverse-coded], detailed; $\alpha = 0.76$) and their interestingness on three items (e.g., appealing, interesting, boring

[1] In addition to picture format, we manipulated participants' construal level mindset via a self-distance prime. Participants either imagined their life tomorrow or in one year for 3 min. Such a self-distance manipulation has been successfully used in previous research to induce a concrete versus abstract mindset (e.g., Bischoff et al., 2020; Förster et al., 2004; Genschow et al., 2019). There were no significant differences between imagining oneself tomorrow ($M = 15.02$, $SD = 4.62$) and imagining oneself in one year ($M = 14.23$, $SD = 4.60$), $t(118) = 0.93$, $p = .35$ on the sum score of the Behavioral Identification Form (BIF; Vallacher & Wegner, 1989), which measures level of construal. This suggests that the self-distancing task was not able to change participants' construal level mindset. We assume that the presentation of emotional stimuli overwrote the manipulation by the imagination task since the BIF was sensitive to differences between picture format but not to differences in self-distance priming. Additionally, there was no interaction between distance, emotion, and muscle, $F(2.62, 306.56) = 0.91$, $p = .43$, and distance, emotion, muscle, and second $F(10.11, 1183.10) = 1.15$, $p = .36$, indicating no modulation of the mimicry reaction by the self-distance priming. For reasons of conciseness and due to no effects on the manipulation check and the mimicry reaction, we dropped the self-distance factor from further discussion here.

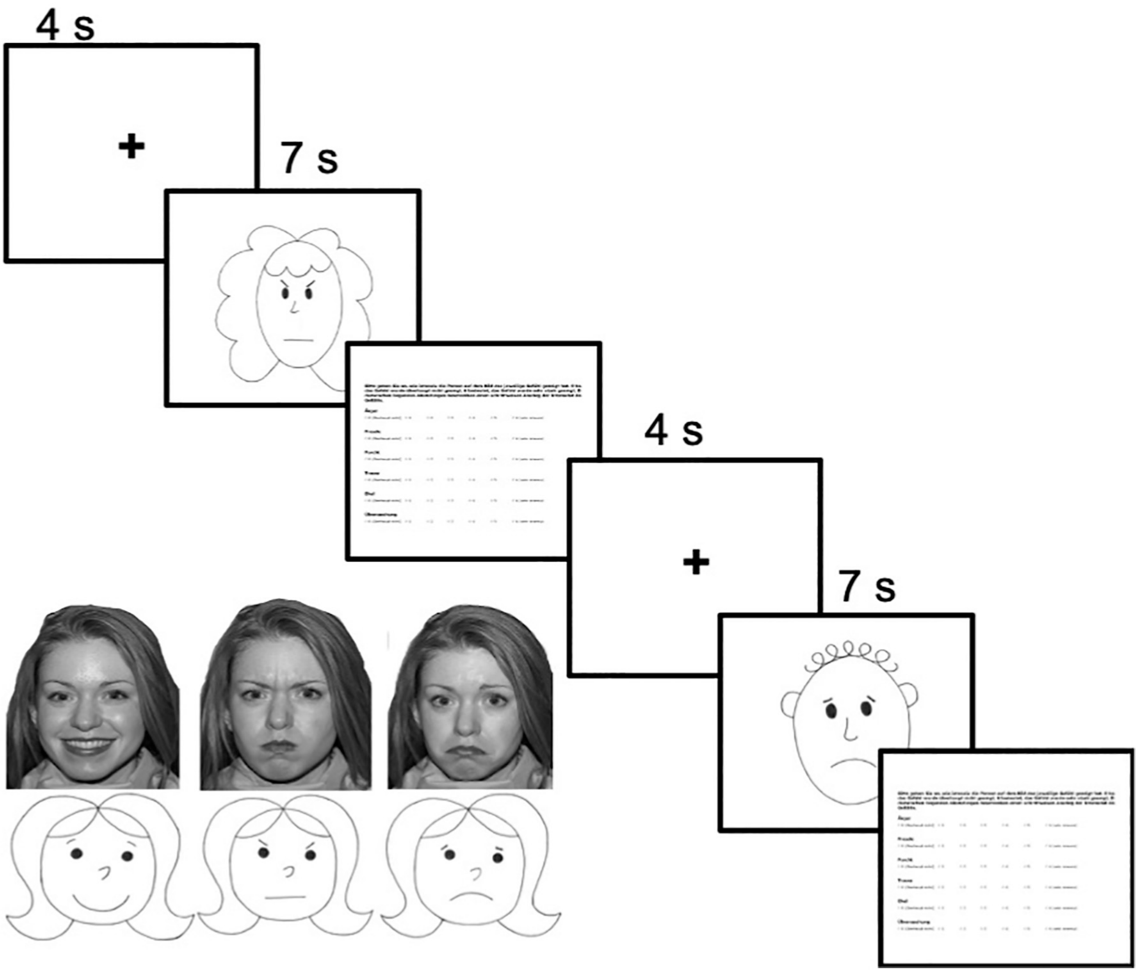


Fig. 1. Examples of two EMG trials for stick figures and an exemplary photograph (model #01) of the NIMSTIM database and an exemplary stick figure showing joyful, angry, and sad expressions.

[reverse-coded], α = 0.74). Next, participants were asked to imagine meeting the group of joyful people and to rate their affiliation with them on four 7-point scales (e.g., "I like these people", "These people are similar to me." α = 0.88).

After the computer part of the experiment, as a manipulation check, participants filled in a German version of the Behavioral Identification Form (BIF) with 24 items (Vallacher & Wegner, 1989) that measures the abstractness level on which actions are identified. In this task, participants were presented with two alternative descriptions of the actions (one more concrete and one more abstract) and chose which of the two best represented the given action. At the end, demographic data were collected, participants were orally probed for suspicions, and participants could leave their email address for further debriefing.[2]

3. Results

3.1. Manipulation checks

3.1.1. Concreteness

Participants who had seen the photographs ($M = 3.93$, $SD = 0.93$) reported higher values of concreteness of the stimuli than participants who had seen the stick figures ($M = 2.16$, $SD = 0.78$), $t(118) = 11.32$, $p < .001$, $d = 2.06$. Also, an independent samples *t*-test on the sum of abstract choices on the 24 BIF items revealed that participants were construing the actions more abstractly when they had seen stick figures ($M = 15.52$, $SD = 4.43$) than when they had seen photographs ($M = 13.73$, $SD = 4.64$), $t(118) = -2.15$, $p = .03$, $d = 0.40$.

3.1.2. Interestingness

Participants thought that the photographs ($M = 3.84$, $SD = 1.24$) were more interesting than the stick figures ($M = 3.08$, $SD = 1.10$), $t(118) = -3.56$, $p = .001$, $d = 0.65$, indicating that photographs provided a richer social context than stick figures.

3.1.3. Affiliation

An independent samples *t*-test revealed that participants who had seen the photographs ($M = 2.78$, $SD = 1.37$) wanted to affiliate with the people depicted in the stimuli as much as participants who had seen the stick figures ($M = 2.99$, $SD = 1.49$), $t(118) = -0.78$, $p = .44$, $d = 0.15$.

[2] We assessed some additional exploratory measures for which we had no specific hypotheses. In the computer part of the experiment, after the emotion rating, participants reported their current physical well-being on 15 items (Hess & Blairy, 2001). The final questionnaire also assessed 16 items of the German version of the Interpersonal Reactivity Scale (Davis, 1980; Paulus, 2009) and one multiple-choice item that asked participants when they had imagined their lives at the beginning of the experiment.

3.1.4. Emotion rating

A 3 (Emotion: happy versus angry versus sad) × 3 (Emotion item: happy versus sad versus angry) mixed ANOVA on the emotion ratings revealed the expected significant two-way interaction between emotion and emotion rating, $F(2.03, 214.99) = 1720.07$, $p < .001$, $\eta_p^2 = 0.94$. Participants correctly assigned more joy compared to sadness or anger to the happy stimuli, more sadness compared to joy or anger to the sad stimuli, and more anger compared to joy or sadness to the angry stimuli, all *ps* $< .001$. Additional exploratory analyses revealed that this pattern was more pronounced in the stick figure than in the photograph condition, as indicated by a significant three-way interaction between emotion, emotion rating, and picture format condition, $F(2.11, 244.77) = 19.66$, $p < .001$, $\eta_p^2 = 0.15$. Simple comparisons showed that they were no differences between photographs and stick figures in joy, anger, and sadness ratings for joyful faces, all *ps* $> .26$. However, participants assigned more anger to angry stick figures than to angry photographs, $p = .001$, and more sadness to angry photographs than to angry stick figures, $p < .001$. Similarly, they assigned more sadness to sad stick figures than to sad photographs, $p = .005$, and more anger towards sad photographs than sad stick figures, $p = .001$ (see Fig. 1). Participants thus recognized the emotions of stick figures more precisely than the emotions of photographs.

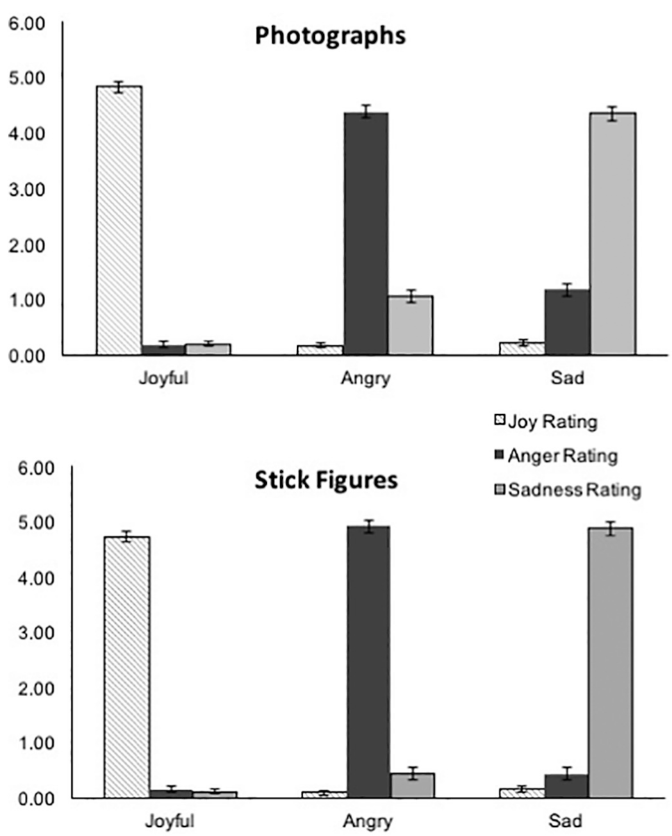


Fig. 2. Ratings of joy, anger, and sadness for each emotion condition for photographs and stick figures. Error bars represent 1 ± *SEM*.

3.2. Facial muscle reaction

After EMG data preparation,[3] a 3 (Emotion: joyful vs. angry vs. sad) × 3 (Muscle: *zygomaticus major* vs. *orbicularis oculi* vs. *corrugator supercilii*) × 7 (Second: 1 vs. 2 vs. 3 vs. 4 vs. 5 vs. 6 vs. 7) × 2 (Format: Photograph vs. stick figure) mixed ANOVA revealed significant two-way interactions between emotion and muscle, $F(2.62, 306.15) = 45.31$, $p < .001$, $\eta^2 = 0.28$, muscle and second, $F(5.92, 627.89) = 5.93$, $p < .001$, $\eta^2 = 0.05$, and a three-way interaction between emotion, muscle, and second, $F(10.09, 1180.64) = 3.87$, $p < .001$, $\eta^2 = 0.032$. No other main effects or interactions were significant, *Fs* < 2.92. Most importantly, this mimicry effect was not further moderated by stimulus format, as indicated by a non-significant three-way interaction between emotion, muscle, and format, $F < 1$, $p = .96$, as well as a non-significant four-way interaction between emotion, muscle, second, and format, $F < 1$, $p = .76$.

For the emotion by muscle interaction, the overall mimicry effect, Helmert contrasts revealed that the activity of the *corrugator* significantly differed from the activity of the *zygomaticus* and *orbicularis*, $F(1, 117) = 85.82$, $p < .001$, $\eta^2 = 0.42$, for joyful versus angry and sad faces. *Zygomaticus* and *orbicularis* activity did not significantly differ from each other for joyful versus angry and sad faces, $F(1, 117) = 2.43$, $p = .122$, $\eta^2 = 0.02$. As Fig. 3 shows, participants' facial reactions converged to the emotion they saw: They showed higher *zygomaticus* and *orbicularis* activity in response to joyful facial expressions and higher *corrugator* activity in response to sad and angry expressions. This effect was independent of the stimulus format.

To complement the frequentist analysis, we additionally conducted a series of Bayesian analyses in jamovi using the default settings (Version 1.1.9.0; The jamovi project, 2019). Bayes factors compare the likelihood of the data under different models and thus indicate the amount of evidence of one model over the other (Dienes, 2014; Wagenmakers et al., 2011).

To assess the evidence for the mimicry effect, we conducted an analysis comparing a model that contained all main effects and interactions (including the interaction of emotion and muscle) to a model that contained all main effects and interactions except the interaction of emotion and muscle. The Bayes factor indicated that the alternative model including the interaction was more likely than the model without interaction, $BF_{10} > 100$. This finding can be interpreted as extreme evidence for the facial mimicry effect (Wagenmakers et al., 2011).

Second, we compared a model that contained all main effects and interactions (including the interaction of emotion, muscle, and second) to a model that contained all main effects and interactions except the interaction of emotion, muscle, and second. The Bayes factor indicated that the alternative model including the interaction was less likely than the model without this three-way interaction, $BF_{10} < 0.01$. This indicates extreme evidence for the model without second as a moderator of the mimicry effect.

[3] For the EMG analysis, one participant was excluded due to a technical error during recording. Movement artifacts (e.g., blinks, swallowing) were removed from the signal; it was band-pass filtered between 30 and 300 Hz and a 50 Hz notch filter, rectified, segmented, and averaged into baseline (−2000 ms before each stimulus onset) and seven trial values for each second of the video presentation (0–1000 ms, 1000–2000 ms, 2000–3000 ms, 3000–4000 ms, 4000–5000 ms, 5000–6000 ms, and 6000–7000 ms) in BrainVision Analyzer 2.1 (Brain Products GmbH). The difference score between each trial and its respective baseline value was then *z*-standardized within each participant and averaged for each second of stimulus presentation within each muscle and emotion condition.

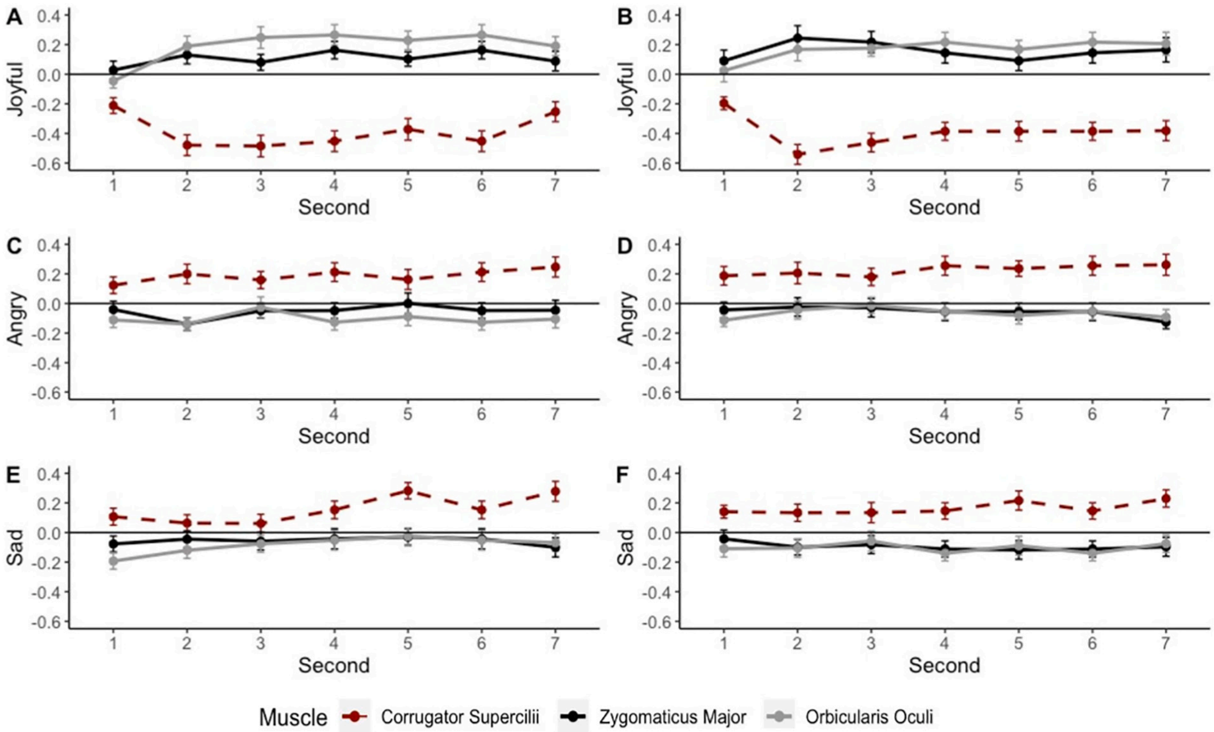


Fig. 3. Baseline corrected and z-standardized muscle reaction towards joyful, angry, and sad photographs (left column: Panels A, C, and E) and stick figures (right column: Panels B, D, and F) during the 7 s stimulus presentation interval. Error bars represent 1 ± *SEM*.

Third, we compared a model that contained all main effects and interactions (including the interaction of emotion, muscle, and picture format) and to a model that contained all main effects and interactions except the interaction of emotion, muscle, and picture format. The Bayes factor indicated very strong evidence for the model without the interaction, $BF_{10} = 0.013$. Finally, for the interaction of emotion, muscle, second, and picture format, the Bayes factor again indicated extreme evidence for the model without the interaction, $BF_{10} < 0.01$.

In summary, a model including the mimicry effect is more likely than a model without a mimicry effect given the current data. However, there is decisive evidence that neither the second of stimulus presentation nor picture format moderated this mimicry effect.

3.3. Exploratory analysis

We predicted the emotion ratings for an emotion from the respective baseline-corrected but unstandardized muscle activity in linear regression (for a similar approach, see Hess & Blairy, 2001). For the joy ratings, neither *zygomaticus* activity, $\beta = -0.02$, $p = .86$, nor *orbicularis* activity, $\beta = 0.10$, $p = .30$, predicted the joy ratings of joyful faces. Also, *corrugator* activity neither predicted ratings of anger for angry stimuli, $\beta = -0.10$, $p = .26$, nor ratings of sadness for sad stimuli, $\beta = 0.07$, $p = .46$. We also looked at the difference scores for emotion recognition and mimicry which represent the interaction terms. As shown in Table 1, the facial mimicry reaction was also not correlated with participants' emotion recognition. In summary, muscle activity did not significantly predict emotion ratings.

Table 1
Correlations between study variables.

	1	2	3	4	5	6	7	8	9	10	11
1. Stimulus format	–										
2. Concreteness	−0.721***	–									
3. Abstraction (BIF)	0.194*	−0.070	–								
4. Interestingness	−0.311***	0.538***	−0.019	–							
5. Affiliation	0.072	0.192*	0.144	0.307***	–						
6. Recognition Joy	−0.017	0.080	0.092	0.072	0.208*	–					
7. Recognition Anger	0.440***	−0.314***	0.028	−0.055	0.100	0.442***	–				
8. Recognition Sadness	0.326***	−0.273**	0.007	−0.213*	0.007	0.453***	0.531***	–			
9. Mimicry Joy	0.010	0.147	−0.117	0.105	0.109	0.124	−0.026	0.033	–		
10. Mimicry Anger	0.020	0.115	−0.099	0.238**	0.229*	0.092	0.045	0.041	0.588***	–	
11. Mimicry Sadness	0.032	0.024	−0.069	−0.121	−0.073	0.040	−0.061	0.024	0.602***	−0.252**	–

Note. BIF = Behavioral Identification Form. Stimulus format is coded as 0 = photographs and 1 = stick figures. Recognition of joy was calculated by subtracting the mean of anger and sad ratings from the mean joy ratings for joyful stimuli, recognition of anger and sadness analogously. Mimicry of joy was calculated by subtracting mean *corrugator* activity from the mean of *zygomaticus* and *orbicularis* activity during joyful stimuli. Mimicry of anger and sadness was calculated by subtracting the mean of *zygomaticus* and *orbicularis* activity from the mean of *corrugator* activity during angry and sad stimuli, respectively.

* $p < .05$.
** $p < .01$.
*** $p < .001$.

4. Discussion

The present study provided evidence for a facial mimicry effect that was independent of the format of the emotional expression. Overall, we found strong evidence for a mimicry effect both with frequentist and Bayesian data analysis approaches, which strengthens our confidence in a general facial mimicry effect and its replicability. Also, participants reacted with congruent muscle reactions towards joyful, sad, and angry facial expressions both for stick figures or photographs. These findings are in line with the assumption that merely perceiving an emotional signal is sufficient for a congruent muscle response to occur in the observer and that facial mimicry happens automatically.

The finding that participants showed facial mimicry in response to stick figures is in line with other recent evidence also showing that stick figures are imitated (Hess et al., 2016). However, in Hess et al.'s (2016) study, mimicry depended on who is sending the emotional message. When participants thought that children had drawn the stick figures, they only showed facial mimicry in response to happy expressions. However, when stroke patients ostensibly had drawn the stick figures, participants showed facial mimicry reactions for happy, angry, and sad expressions, consistent with our results. When giving participants no information about who is sending an emotional message via the stick figures, people seem to infer meaning from these abstract emotional depictions and thus behave congruently with these inferences, independent of the emotion shown. Our findings extend these previous results by showing that stick figures were mimicked to a comparable amount as photographs.

In the introduction, we considered facial mimicry as stronger in response to photographs than to stick figures because (1) stick figures provide a poorer affiliative and less socially meaningful context than photographs and (2) stick figures are perceived as psychologically more distant than photographs (which both would reduce mimicry). In contrast to this hypothesis, we did not find that participants mimicked photographs more than stick figures. This null finding may be explained by the fact that stick figures are more prototypical than photographs, causing a stronger activation of the recognized emotion. In fact, abstract faces (e.g., iconic faces) communicate emotional information more efficiently than realistic faces (Kendall et al., 2016). Additionally, abstract faces (i.e., emoticons) convey emotions by activating brain regions that are responsible for emotional valence detection (the right inferior frontal gyrus) without activating brain regions associated with face perception (the right fusiform gyrus; Yuasa et al., 2006).

To the extent that facial mimicry is driven by the recognition of an emotion (but not necessarily by recognition of a face), participants may actually have been more likely to show facial mimicry in response to stick figures than photographs. However, enhanced activation of emotional information and decreased psychological distance with a poorer affiliative and socially meaningful context may have canceled each other out when mimicking stick figures, causing the same extent of facial mimicry in response to stick figures and photographs (and possibly the unrelatedness of mimicry and emotion recognition, as discussed below).

The null finding is in line with other recent evidence. For example, it has been shown that facial mimicry of negative emotions did not differ in response to ingroup compared to outgroup members (Sachisthal et al., 2016). However, the study by Sachisthal et al. (2016) overall did not find a facial mimicry effect for negative emotions. Mimicry was measured with an automated video coding software (i.e., FaceReader), which is not sensitive towards subtle changes in muscle activity that cannot be externally observed. Thus, it is not clear whether the previous null findings were due to the low sensitivity of the measure. In our study, a more sensitive facial EMG procedure was used that can capture slight differences in muscle activity even if these are not externally observable. Although a facial mimicry effect occurred for joyful, angry, and sad faces with this procedure, the social-cognitive context did still not moderate this effect.

Additionally, the present null effect of presentation format is an interesting extension of previous research on Simon-like compatibility effects (Otte, Habel, et al., 2011; Otte, Jost, et al., 2011). These studies showed compatibility effects for photographs of emotional faces. It would be interesting to replicate these findings with stick figures. We assume that the compatibility effect, that is, faster reactions towards stimuli that display emotions corresponding to the required action, should be similar for photographs and stick figures.

Although the present study did not show a difference between mimicry of photographs and mimicry of stick figures, other research did find differences in mimicry depending on the intenseness of the stimulus. For instance, dynamic faces are more likely to be mimicked than static faces (Sato et al., 2008; Sato & Yoshikawa, 2007). Such previous findings can be interpreted in terms of construal level: The more realistic and intense a stimulus is, the more likely it is construed on a concrete level, which enhances imitative tendencies (Hansen et al., 2016; Wessler & Hansen, 2017). The construal difference between a concrete photograph and a more abstract stick figure may be comparable to the construal difference between a concrete dynamic and a more abstract static facial expression. In contrast to static and dynamic photographs, however, especially the stick figures may have facilitated emotion detection (Yuasa et al., 2006), reducing the possible mimicry difference between stick figures and photographs, even if (and presumably because) stick figures are more abstractly construed.

As in previous research, the facial mimicry reaction and emotion recognition were unrelated (Hess & Blairy, 2001). Interestingly, the stimulus format did not influence mimicry, but it did influence emotion recognition. Participants were better able to detect distinct basic emotions displayed in stick figures than in photographs. Stick figures were perceived as more abstract depictions of emotion, and emotion recognition might profit from holistic processing.

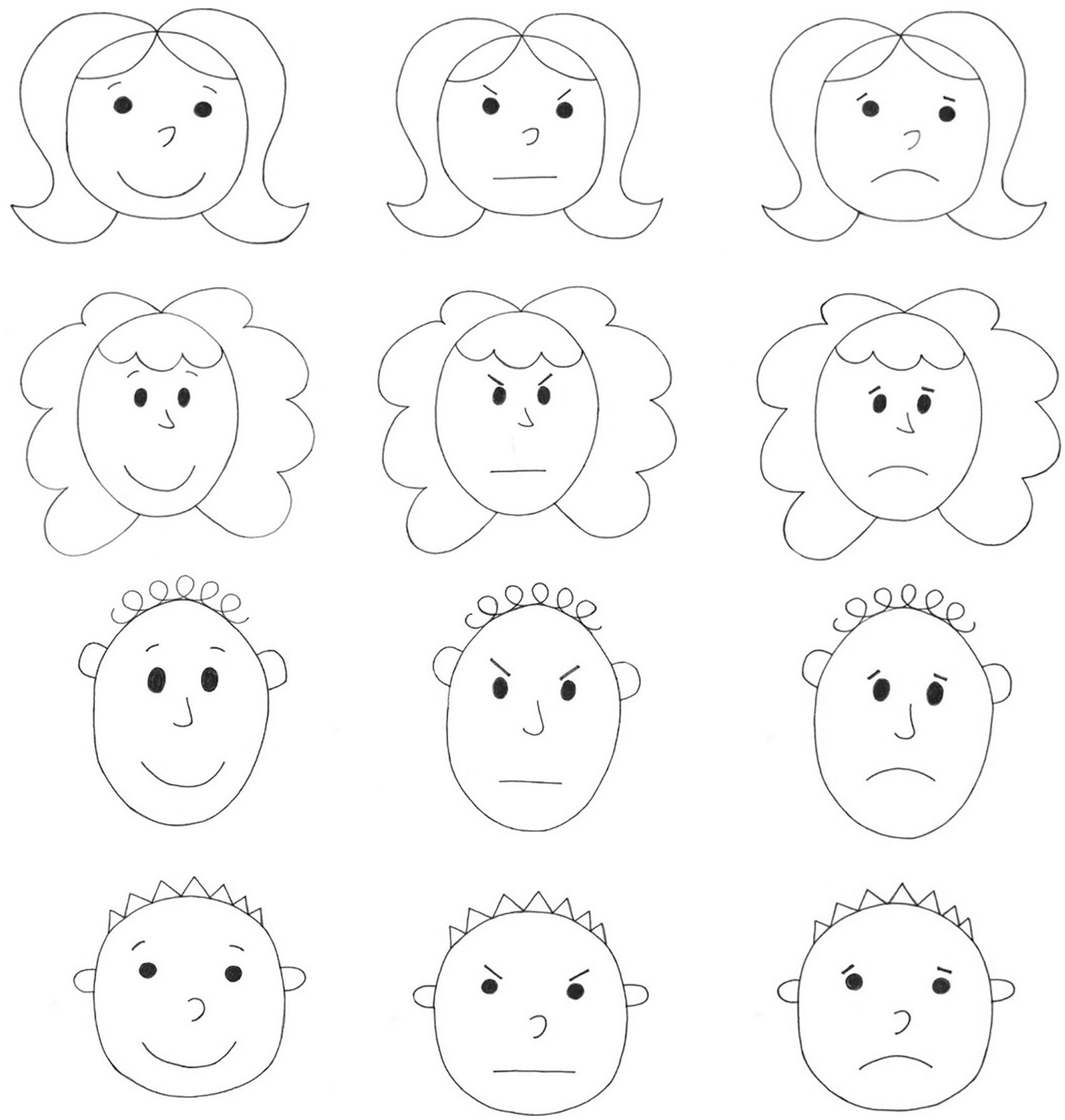
Additionally, real human faces are complex and convey a range of information, whereas stick figures are more prototypical. This may be the reason why participants had more difficulties to infer an emotional meaning from faces than from stick figures. This finding supports the theory of constructed emotions (Barrett, 2017; Barrett et al., 2011) which calls into question the common assumption that individuals reliably recognize certain emotions in specific facial configurations. Instead, it argues that all emotions are socially constructed, which leaves a lot of room for situated variability when inferring emotions from facial configurations. To the extent that real human faces (vs. stick figures) include more context and thus more strongly activate variable, situated cognition, it is no surprise that participants were better able to attribute emotions to the prototypical stick figures than to the more complex human faces. All the more surprising is the finding that facial mimicry of stick figures and faces on photographs did not vary, which suggests that facial mimicry is less situated than the attribution of emotions.

CRediT authorship contribution statement

Janet Wessler: Conceptualization, Methodology, Formal analysis, Investigation, Writing, Original draft, Writing-Review & editing, Visualization

Jochim Hansen: Conceptualization, Writing-Review & editing, Supervision, Funding acquisition.

Appendix A



A1. Stick figures used in this study.

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