Facial Mimicry of Spontaneous and Deliberate Duchenne and Non-Duchenne Smiles

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Abstract

Increasing evidence suggests that Duchenne (D) smiles may not only occur as a sign of spontaneous enjoyment, but can also be deliberately posed. The aim of this paper was to investigate whether people mimic spontaneous and deliberate D and non-D smiles to a similar extent. Facial EMG responses were recorded while participants viewed short video-clips of each smile category which they had to judge with respect to valence, arousal, and genuineness. In line with previous research, valence and arousal ratings varied significantly as a function of smile type and elicitation condition. However, differences in facial reactions occurred only for smile type (i.e., D and non-D smiles). The findings have important implications for questions relating to the role of facial mimicry in expression understanding and suggest that mimicry may be essential in discriminating among various meanings of smiles.

Keywords: facial expression, Duchenne smile, mimicry, deception, EMG

The distinction between genuine displays of enjoyment and those that are posed devoid of any positive emotion depicts an important aspect in social interaction. Only if perceivers are sensitive to deliberate attempts of affective signals can they infer the person's true emotional state and accurately predict future behavior. The Duchenne (D) smile has been proposed as a necessary marker of felt positive emotions such as happiness, pleasure or enjoyment (Ekman, 1992; Ekman, Davidson, & Friesen, 1990; Frank & Ekman, 1993). Originally described by the French neuroanatomist Duchenne de Boulogne (1862/1990), it is characterized not only by the *zygomaticus major* muscle which pulls the lip corners up, thereby producing a smiling mouth, but also by a second muscle: the *orbicularis oculi, pars lateralis* muscle which causes a lifting of the cheeks, narrowing of the eye opening, and gathering of the skin around the eye- called crow`s feet wrinkles (Ekman & Friesen, 1982). It has been argued that particularly this latter muscle provides a reliable sign of enjoyment because it is difficult to feign by the majority of population and therefore not available for use in false expressions (Ekman, Roper, & Hager, 1980; Frank & Ekman, 1993).

Indeed there is evidence that D smiles occur more often in circumstances of spontaneously experienced positive affect (e.g., Ekman, Friesen, & O'Sullivan, 1988; Frank, Ekman, & Friesen, 1993). Moreover, perceivers can reliably distinguish between D and non-D smiles. When viewing both smile types, it has been found that D smiles lead to more positive evaluations of the sender (Frank et al., 1993; Harker & Keltner, 2001; Mehu, Little, & Dunbar, 2007; Quadflieg, Vermeulen, & Rossion, 2013), perceptions of greater emotional positivity and spontaneity/authenticity of the expression (e.g., Gosselin, Perron, Legault, & Campanella, 2002; Hess & Kleck, 1994; Messinger, 2002; Miles & Johnston, 2007), as well as more favorable behavioral responses in the other person (Johnston, Miles, & Macrae, 2010; Miles, 2009). Together, these findings suggest that there is some association between D smiles and the expression/perception of positive emotions.

Nonetheless, the spontaneous nature of this particular type of smile should not be unquestioned. An increasing amount of evidence suggests that people can and do display D smiles deliberately and in the absence of positive feelings. For example, D smiles have been observed in conditions when participants were instructed to smile voluntarily (Schmidt, Ambadar, Cohn, & Reed, 2006), while saying a positive-affect message to the camera and imitating on purpose a D smile expression (Gunnery, Hall, & Ruben, 2013), or when asked to voluntarily activate the lip corner puller (i.e., *zygomaticus major* muscle; Gosselin, Perron, & Beaupré, 2010). For such posed smiles, a substantial proportion of expressions involved the D marker (e.g., Krumhuber & Manstead, 2009; Schmidt & Cohn, 2001; Schmidt, Bhattacharya, & Denlinger, 2009; Smith, Smith, & Ellgring, 1996). Furthermore, a number of studies have found D smiles in negative contexts, for example in response to negative film clips, after failure in a game or when talking about negative events (e.g., Ekman et al., 1990; Lee & Beattie, 1998; Schneider & Josephs, 1991). Based on these findings it therefore appears that D smiles not only occur as a sign of genuine felt enjoyment.

An interesting question is how spontaneous and posed D smiles are perceived by others. In a recent study, we found that participants distinguished between smiles of these two kinds of elicitation when rating the genuineness of the expression (Krumhuber & Manstead, 2009). But, would such difference also be visible in the facial reactions to these smiles? Typically, people react with congruent facial patterns when observing a vis-à-vis' emotional facial expression (e.g., Dimberg, 1982; Likowski, Mühlberger, Seibt, Pauli, & Weyers, 2008; Likowskiet al., 2011a). This phenomenon is termed facial mimicry and is supposed to appear automatically and outside conscious awareness (Dimberg, Thunberg, & Elmehed, 2000; Dimberg, Thunberg, & Grunedal, 2002). Such mirroring can facilitate the understanding of other people's emotions and intentions by allowing one to reproduce what others are experiencing (Atkinson & Adolphs, 2005; Likowski et al., 2012; Niedenthal, Brauer, Halberstadt, & Innes-Kehr, 2001; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000; Oberman, Winkielman, & Ramachandran, 2007; Stel & van Knippenberg, 2008). Facial mimicry has been further implicated in creating and maintaining smooth interactions and positive relationships (Chartrand & Bargh, 1999; Lakin, Jefferis, Cheng, & Chartrand, 2003). Clearly, there is a beneficial effect of mimicry in expression perception and interaction. But, does this also apply to smiles of different motivated nature? Do people equally mimic D smiles that are spontaneous or posed? Up to now, facial activity has been measured (using EMG) only while viewing D and non-D smiles (Surakka & Hietanen, 1998). Interestingly, in that study both types of smiles were posed by actors and consisted of static representations in the form of images. Moreover, a difference in facial EMG reactions could be shown only between D smiles and neutral expressions, but not between D and non-D smiles. Apart from the questionable ecological validity, such expressions may lack information inherent to the distinction between smile types.

The present research aimed to extend previous work by using D and non-D smiles that were spontaneous as well as posed. To our knowledge, no study has looked so far at facial reactions to these different types of expressions. In this study, stimuli were dynamic in their nature and consisted of short video-clips of D and non-D smiles being elicited under spontaneous and deliberate conditions (Krumhuber & Manstead, 2009). To investigate whether perceivers' facial responses are sensitive to the different smile types and elicitation conditions, we measured facial EMG activity over the cheek (M. *zygomatic major*), eye (M. *orbicularis oculi*), and brow region (M. *corrugator supercilii*). Given that the muscular reaction pattern towards happy faces has previously been shown to be a combination of Zygomaticus activation and Corrugator deactivation (see Likowski et al., 2008; 2011a, 2011b; Weyers, Mühlberger, Kund, Hess, & Pauli, 2009), and Orbicularis oculi activity is the best approximation for electromyographically measuring the Duchenne smile, we were interested in the covariation of the reactions of these three facial muscles to the smile expressions. In addition, perceivers' subjective ratings of those smiles were obtained with respect to valence, arousal and genuineness.

Method

Design and Participants

The experiment consisted of a 2 (smile type: D vs. non-D) x 2 (elicitation condition: spontaneous vs. deliberate) within-subjects design.

Participants were 30 students from the University of Würzburg, Germany. They were recruited by local internet announcements and received 8€ for participation. Recruitment was limited to female subjects because of earlier findings (Dimberg & Lundqvist, 1990) indicating that women show more pronounced, but not qualitatively different, mimicry effects than male subjects. Data from three participants had to be excluded from analyses due to technical problems or extreme EMG artifacts (more than 30% of the trials). Statistical analyses were computed for the remaining sample of 27 participants, between 19 and 30 years of age (M = 23.73 years; SD = 2.72).

Stimulus Material

Stimuli consisted of dynamic smile expressions of male and female targets as developed and described in Krumhuber and Manstead (2009). Smiles were elicited either under spontaneous or deliberate conditions. Spontaneous smiles resulted from viewing amusing material (i.e., reading jokes, viewing a cartoon or funny film clips, each of which lasted approximately 15 s), whereas deliberate smiles resulted from posing a smile while viewing neutral pictures (i.e., images of objects which were displayed for 10 s each). From the total set of stimuli smile displays were selected that a) began and ended with a neutral baseline expression and b) were accompanied by moderate to high positive emotions of the sender (i.e., pleasure, amusement and happiness ratings of 3 or higher on a 7-point scale where 1 = *not at all* and 7 = *extremely*) in the spontaneous condition and low or no emotions of the sender (i.e., pleasure, amusement and happiness ratings of 2 and lower) in the deliberate condition.

Within each of the two elicitation conditions, there were 6 exemplars of D and non-D smiles that fit the above criteria, resulting in a set of 24 smile expressions: (a) 6 spontaneous D smiles; (b) 6 spontaneous non-D smiles; (c) 6 deliberate D smiles; and (d) 6 deliberate non-D smiles. Overall, the intensity of spontaneous D smiles (M = 3.0) was similar to that of spontaneous non-D smiles (M = 2.2, p = .11) and deliberate D smiles (M = 3.5, p = .27). The same was the case for non-D smiles, which did not differ with respect to intensity between the spontaneous and deliberate conditions (M = 2.2 vs. M = 2.0, p = .69). All smile expressions were comparable in terms of asymmetry, $F(3, 20) = 2.16$, $p = .12$, $\eta_p^2 = .24$, irregularity, $F(3, 20) = 0.44$, $p = .72$, $\eta_p^2 = .06$, and the presence of non-positive facial actions, $F(3, 20) = 0.44$, $p = .72$, $\eta_p^2 = .06$. There were no significant differences between the four smile types in onset duration (M = 0.99 s), $F(3, 20) = 1.80$, $p = .18$, $\eta_p^2 = .21$, or offset duration (M = 1.85 s), $F(3, 20) = 1.62$, $p = .21$, $\eta_p^2 = .20$, with the only exception of spontaneous non-D smiles being shorter in their apex durations (M = 0.48 s) than the other smile types (M = 3.17 s), $F(3, 20) = 10.70$, $p < .001$, $\eta_p^2 = .62$.

Facial EMG

Facial muscular responses were assessed electromyographically on the left side of the face. To measure the activity of *M. zygomaticus major* (pulls the lip corners up), *M. corrugator supercilii* (lowers and furrows the eyebrows), and *M. orbicularis oculi* (produces wrinkles around the eye socket), two 13/7 mm Ag/AgCl miniature surface electrodes for each muscle were attached to the corresponding muscle sites according to the guidelines by Fridlund and Cacioppo (1986) with a forehead electrode as a common reference. The ground electrode was applied behind the left ear (left mastoid). Impedance for all electrodes was kept below 10 kΩ. The EMG raw signal was measured with a digital amplifier (V-Amp 16, Brain Products Inc., Munich, Germany), digitalized by a 16-bit analog-to-digital converter, and stored on a personal computer with a sampling frequency of 1,000 Hz. Before further processing, the difference of each two electrodes from the same muscle site was computed.

The stored EMG raw signals were filtered offline with a 30-Hz low cutoff filter, a 500-Hz high-cutoff filter, a 50-Hz notch filter and rectified and transformed with a 125 ms moving average filter. For statistical analysis, EMG data were collapsed over the 6 videos (due to lack of any significant effects of exemplar in preliminary tests) for each smile type and elicitation condition. Then reactions were averaged over the first 2 s of stimulus exposure and transformed into mean change scores from baseline. We chose this interval of the first 2 s of each video because the shortest video duration was 2 s. The baseline corresponded to the average muscular activity 1 s before each stimulus onset and was set to zero. Artifacts in the baseline defined as fluctuations of more than ± 8 µV, and artifacts during picture presentation defined as fluctuations of more than ± 30 µV were excluded from data analyses (less than 5%).

Procedure

Participants were tested individually in a laboratory room. After giving their written consent, electromyography (EMG) electrodes were placed. To conceal the recording of facial muscle activity, participants were told that skin conductance would be recorded (see Dimberg et al., 2000). They were then informed that they would see short video clips displaying different expressions of several people. The 24 smile expressions were presented in randomized order, preceded by a warning pitch tone and a centrally located fixation cross 3 s before stimulus onset. Inter-trial intervals varied from 14 s to 16 s during which participants saw an empty white screen. To ensure that participants paid attention to the stimuli, we told them that they would be asked about the stimuli later. While viewing the videos *M.*

zygomaticus major, *M. orbicularis oculi*, and *M. corrugator supercilii* were recorded electromyographically.

Afterwards, subjective responses to the smile expressions were assessed for which the videos were presented again. After each video clip participants answered on 9-point Likert scales the following three questions relating to valence, arousal, and genuineness: (a) “How negative/positive do you find the video?” (1 = *very negative*, 9 = *very positive*), (b) “How arousing do you find the video?” (1 = *very*, 9 = *not at all*), and (c) “How genuine do you find the shown expression?” (1 = *not at all*, 9 = *very*). Finally, participants were probed for suspicion, debriefed, paid, and thanked. None were aware of the hypotheses, and none suspected that facial muscular reactions were measured.

Results

Separate repeated measures analyses of variance (ANOVAs) were conducted for each muscle site and subjective rating, with smile type (D vs. non-D) and elicitation condition (spontaneous vs. deliberate) as within-subjects factors. For all ANOVAs, a Greenhouse-Geisser adjustment of degrees of freedom was applied. Paired-samples *t*-tests (two-tailed) were used to further examine effects of significant interactions.

Facial EMG

M. zygomaticus major. Results revealed a significant main effect of smile type, $F(1,25) = 5.22$, $p = .03$, $\eta_p^2 = .17$. Specifically, *M. zygomaticus* activity was stronger in response to D smiles ($M = 0.27$, $SE = 0.13$) compared to non-D smiles ($M = 0.12$, $SE = 0.10$, see Figure 1). The main effect of elicitation condition as well as the interaction of Smile Type x Elicitation Condition did not gain significance, both *p*s > .44.

M. orbicularis oculi. There was a significant main effect of smile type, $F(1,25) = 4.38$, $p = .04$, $\eta_p^2 = .15$. Similarly as the above results, *M. orbicularis oculi* activation was higher in response to D smiles ($M = 0.45$, $SE = 0.19$) compared to non-D smiles ($M = 0.15$, *SE*

= 0.07), suggesting that participants displayed congruent facial mimicry in response to the two smile types. The main effect of elicitation condition as well as the interaction of Smile Type x Elicitation Condition were not significant, both *p*s > .10.

M. corrugator supercilii. Results revealed a main effect of smile type, $F(1,25) = 16.20$, $p < .01$, $\eta_p^2 = .39$. Specifically, *M. corrugator* activation was lower in response to D smiles ($M = -0.87$, $SE = 0.18$) compared to non-D smiles ($M = -0.37$, $SE = 0.11$), indicating stronger relaxation of the eyebrow muscle when viewing D smiles. The main effect of elicitation condition as well as the interaction of Smile Type x Elicitation Condition did not gain significance, both *p*s > .20.

Subjective Ratings

Valence. A repeated measures ANOVA revealed a significant main effect of smile type, $F(1,25) = 87.51$, $p < .01$, $\eta_p^2 = .78$, and of elicitation condition, $F(1,25) = 11.23$, $p < .01$, $\eta_p^2 = .31$. These effects were qualified by a significant interaction between smile type and elicitation condition, $F(1,25) = 9.84$, $p < .01$, $\eta_p^2 = .28$. Overall, the results were highly similar to those reported by Krumhuber and Manstead (2009, for perceived amusement) with a large subset (80%) of stimuli shared in this study. The following *t*-tests showed that participants were sensitive to the presence or absence of the D marker within each condition, although such differences in the ratings of D and non-D smiles were greater in the spontaneous than in the deliberate condition (see Table 1). Spontaneous D smiles were rated as more positive than spontaneous and deliberate non-D smiles, $t(25) = 8.15$, $p < .01$, and $t(25) = 6.59$, $p < .001$, respectively. Similarly, deliberate D smiles were judged to be more positive than deliberate and spontaneous non-D smiles, $t(25) = 6.36$, $p < .001$, and $t(25) = 8.08$, $p < .001$, respectively. As in Krumhuber and Manstead (2009), participants did not distinguish between spontaneous and deliberate D smiles, $t(25) = .12$, $p = .91$. However, valence ratings were higher for deliberate compared to spontaneous non-D smiles, $t = 4.63$, $p < .01$, suggesting that among non-D smiles those made deliberately appear more positive than those made spontaneously (see Krumhuber & Manstead, 2009, Experiment 2 and 3 for similar results of amusement).

Arousal. A significant main effect of smile type emerged, $F(1,25) = 87.51$, $p < .01$, $\eta_p^2 = .78$. From inspection of the means, D smiles ($M = 5.37$, $SE = 0.15$) were rated as more arousing than non-D smiles ($M = 6.18$, $SE = 0.18$). The main effect of elicitation condition and the interaction of Smile Type x Elicitation Condition did not reach significance, both *p*s > .19.

Genuineness. Results revealed a significant main effect of smile type, $F(1,25) = 15.81$, $p < .01$, $\eta_p^2 = .39$, and a marginal main effect of elicitation condition, $F(1,25) = 4.13$, $p = .05$, $\eta_p^2 = .14$. These effects were qualified by a significant interaction of smile type and elicitation condition, $F(1,25) = 23.06$, $p < .01$, $\eta_p^2 = .48$. The results were identical to those by Krumhuber and Manstead (2009) using some of the same stimuli. *T*-tests showed that spontaneous D smiles were judged as more genuine than spontaneous and deliberate non-D smiles, $t(25) = 6.29$, $p < .01$, and $t(25) = 6.07$, $p < .001$, respectively. For deliberate smiles, participants did not distinguish in their genuineness ratings between D and non-D smiles, $t(25) = 0.75$, $p = .46$, showing that they perceived both smile types as less sincere. Judgements of the genuineness of D smiles varied significantly between the spontaneous and deliberate condition. In particular, spontaneous D smiles received higher ratings of genuineness than did deliberate D smiles, $t(25) = 3.78$, $p < .01$. In line with the findings from Krumhuber and Manstead (2009), this supports the notion that the spontaneous D smile is perceived as the most genuine, felt smile in the eye of beholder. There was no significant effect of elicitation condition on the perceived genuineness of non-D smiles, $t(25) = 1.77$, $p = .09$.[1]

Discussion

The aim of the present experiment was to examine facial reactions and subjective responses to spontaneous and deliberate D and non-D smiles. The EMG data revealed an effect of smile type (D vs. non-D) on facial mimicry. Participants reacted with an overall enhanced congruent reaction pattern to D compared to non-D smiles in all three facial muscles. This was the case especially for the M. *orbicularis oculi* as the defining feature (the "Duchenne marker") for differentiating D from non-D smiles, as well as the M. *corrugator supercilii* which allows reciprocal de/activation by both negative and positive affect due to its large range in reaction potential (e.g., Larsen, Norris, & Cacioppo 2003). Results thereby extend research by Surakka and Hietanen (1998) who could only show differences in facial reactions to neutral and D smiles as well as neutral and non-D smiles, but not between D and non-D smiles. This may be attributable to the type of stimulus material previously used which consisted of static photographs of posed D and non-D smiles. In the present study, naturalistic videos were employed depicting smiles made spontaneously and deliberately, thereby representing more ecologically valid stimuli for the discrimination between smile types.

Interestingly, there was no difference in EMG reactions between deliberate and spontaneous smiles. For both D and non-D smiles, both elicitation conditions led to similar levels of facial mimicry, suggesting that participants mimicked spontaneous and deliberate smiles equally. One might speculate that participants were not aware of the respective nature of the smile expressions. However, results for the subjective ratings discard this assumption. Participants generally distinguished between spontaneous and deliberate smiles, suggesting that self-report ratings and facial mimicry were likely tapping into different systems. While mimicry occurred on a rather automatic or subconscious level, smiles were evaluated in a relatively explicit and conscious manner, thereby allowing for a differentiated pattern as a function of elicitation condition.

Overall, judgment ratings were highly similar and corroborated the findings by Krumhuber and Manstead (2009, Experiment 2 & 3) with a large set of shared stimuli. In both studies participants judged D smiles as more positive/amused than non-D smiles and deliberate non-D smiles as more positive/amused than spontaneous non-D smiles. Furthermore, D smiles received higher genuineness ratings than non-D smiles in the spontaneous condition, and spontaneous D smiles were seen as more genuine than deliberate ones. Altogether, spontaneous D smiles gained the most positive and genuine ratings, consistent with the notion that these smiles are perceived as expressing felt positive emotion (e.g., Frank, Ekman, & Friesen, 1993; Gosselin, Perron, Legault, & Campanella, 2002). Interpreting these findings in the light of similar facial reactions to spontaneous and deliberate smiles, both within the D and non-D smile category, the EMG data thus might reflect more than pure valence or genuineness. Instead they parallel our arousal ratings indicating that participants were more aroused by D than by non-D smiles. Similar results have been reported in past research (Greenwald, Cook, & Lang, 1989; Larsen et al., 2003) showing that EMG activity tends to increase with higher ratings of arousal. Given that arousal may correspond to the intensity of emotion (Lang, Bradley, & Cuthbert, 1998), the findings are in line with previous data (e.g., Krumhuber & Manstead , 2009; Gunnery et al., 2013; Messinger, Cassel, Acosta, Ambadar, & Cohn, 2008) showing that D smiles are of higher intensity containing additional activity, e.g., in the eye region (the “Duchenne marker”). This connection between the EMG pattern and arousal/intensity of the expression (see also Fujimura, Sato, & Suzuki, 2010) supports the assumption that people mimic what they see in terms of apparent structural features. The more intense they perceive an expression the more they show congruent facial reactions.

The findings necessitate further conceptual clarity in the distinction between genuine and fake smiles. In past research, terms and concepts have often been intermixed. That is, classifications of smiles based on morphological features (i.e., Duchenne marker) were interrelated with descriptions based on the accompanying psychological state. As such, D smiles were treated as a representation of spontaneous/genuine feelings of enjoyment despite the fact that they constituted in many cases posed expressions. In future studies, it will be essential to separate these two constructs and to test for the effects of structural features and affective state independently. Furthermore, with respect to structural features, additional work might be desirable to control for the role of smile intensity. While the present research aimed to match D and non-D smiles for intensity to a large extent, we were unable to achieve perfect matching of smile type in both elicitation conditions. Given that we wanted to investigate the imitation of naturalistic dynamic expressions (as opposed to static and posed ones, see Surakka & Hietanen, 1998), smile intensity therefore remains a potential confounding variable in the effects of D smiles (Gunnery et al., 2013).

Nonetheless, we think that the present results have important implications for questions relating to the interpretation of emotional expressions and the role of facial mimicry. Following prominent models on emotion recognition (Lipps, 1907; Goldman & Sripada, 2005) and several consequent empirical studies facial mimicry serves to facilitate understanding other people's emotions by simulating the other vis-à-vis' state (Atkinson & Adolphs, 2005; Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000; Wallbott, 1991). Accordingly, facial mimicry may function as a promising means to detect not only the sender's emotion per se but also whether someone is actually feeling or just posing it (see Hess & Fischer, 2013 for an overview). Supportive evidence comes from studies in which mimicry was constrained, showing that people were slower and less able to recognize emotional expressions and to determine whether a smile was genuine or fake (Maringer, Krumhuber, Fischer, & Niedenthal, 2011; Oberman, Winkielman, & Ramachandran, 2007; Stel & Knippenberg, 2008). Facial mimicry via the respective or other muscles may therefore contribute to the perceived meaning of expressions, allowing for subtle distinctions between smiles of different nature.

Future research is needed to further explore the role of mimicry in the perception of mixed and ambiguous smile expressions. Previously, emotional contagion was argued to be a direct result of mimicry, thereby making it harder to detect someone's true emotional state and distinguish between liars and truth tellers (Stel, van Dijk, & Olivier, 2009). We think it is important to apply a micro-analytic approach by investigating what type of smiling behavior exactly is being mimicked, in what time window mimicry occurs (here studies still vary considerably), and whether this occurs inside or outside of social context.

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Footnote

[1] Similarly as in Krumhuber and Manstead (2009) a trend was observed for other facial features to predict participants' subjective ratings: valence (apex duration: $\beta = .60$, $p = .03$; asymmetry: $\beta = -.36$, $p = .07$), and arousal (apex duration: $\beta = -.57$, $p = .07$). Smile intensity was found to be a significant predictor for ratings of valence only ($\beta = .49$, $p = .02$). When controlling for the role of smile intensity, the relationship between smile type (D vs. non-D) and perceptions of valence however remained significant ($r_{partial} = .40$, $p = .05$).

Table 1. Means and Standard Errors for Ratings of Valence, Arousal and Genuineness as a Function of Smile Type and Elicitation Condition.

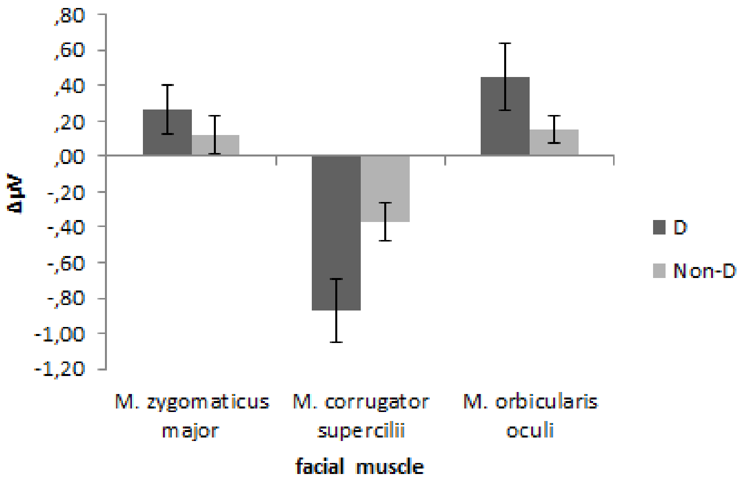
	Spontaneous				Deliberate			
	Duchenne		non-Duchenne		Duchenne		non-Duchenne	
Measure	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Valence	6.40_a	0.14	4.70_b	0.14	6.42_a	0.16	5.44_c	0.13
Arousal	5.37_a	0.15	6.33_b	0.23	5.38_a	0.20	6.02_b	0.17
Genuineness	6.77_a	0.18	5.19_b	0.23	5.71_b	0.26	5.50_b	0.18

Note. All ratings were made on 1-to-9 Likert scales, with higher scores indicating greater levels of that dimension for valence and genuineness. For arousal ratings higher scores indicate lower levels of arousal. Row means with different subscripts differ at $p \leq .05$ or better.

Figure caption

Figure 1. Mean EMG change in µV for *M. zygomaticus major*, *M. corrugator supercilii* and *M. orbicularis oculi* in response to D and non-D smiles. Error bars indicate standard errors of the means.

Fig. 1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M. zygomaticus major
M. corrugator supercilii
M. orbicularis oculi
facial muscle
D
Non-D