VOLUNTARY MIMICRY, MOOD AND EMPATHY

by

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Prompted Imitation of the Duchenne Smile, Mood and Empathy

A Thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts at George Mason University

by

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DEDICATION

With love and gratitude, to my parents, Thomas and Nancy Willis.

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ABSTRACT

PROMPTED IMITATION OF THE DUCHENNE SMILE, MOOD AND EMPATHY

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Previous research has documented the social, physiological and cognitive properties of the Duchenne smile. No previous studies have been conducted to assess accuracy during repeated, prompted imitation of the Duchenne smile. The present study investigated the effects of such repeated, prompted imitation of both social and Duchenne smiles on mood and responses to a verbal prompt to smile, as well as accuracy of imitation over several time points. Relationships with self-reported empathy were also examined. The 50, predominately (84%) female, undergraduate participants were randomly assigned to two groups. Both groups of participants were asked to imitate a total of ten facial expressions including expressions of sadness and anger. One group was asked to imitate six consecutive social smiles and the other was asked to imitate six consecutive Duchenne smiles. Friedman ANOVAs revealed stable imitative inaccuracies for both groups of participants over the course of repeated imitation attempts. Both the social smile and Duchenne smile groups reported significantly increased mood following repeated imitation. No differences between groups were found in responses to verbal prompts to smile. Empathy was found to be unrelated to accuracy of voluntary mimicry (the type of imitation investigated in this study). Results suggest that training may be necessary for some individuals to learn to accurately reciprocate Duchenne smiles. Implications and suggestions for future research are discussed.

INTRODUCTION

Imagine for a moment that you are walking across campus to deliver a lecture to a class. Shortly after you start walking, you see someone coming. As they pass you, they give you a big smile. Moments later you meet another person and they also smile intensely at you. You keep walking and, sure enough, the next person you encounter gives you yet another radiant smile. Imagine how it would feel if you received six such smiles in a row before you got to your classroom. You might be inclined to check your appearance in a mirror before you begin class or you might think that you look particularly good that day. Despite being wrapped up in thinking about your upcoming lecture, by the third or fourth smile you may actually have smiled back. Would these brief smiling encounters have any effect on your own emotions and emotional displays as you begin to greet students coming into your classroom? Now imagine that you had attempted to smile back at each of the people you met. Would it have been easier to return the smile of the first person or the last person? Would the type of smiles you received matter? Would your attempts to mimic the smiles have improved from the first encounter to the last? The research outlined below suggests that both the type of smile received and the attempts to mimic those smiles will impact the likelihood of an elevated positive mood and genuine positive affect display following this set of encounters.

The purpose of the present study is to investigate possible effects of repeated voluntary mimicry of the Duchenne smile on mood, and the voluntary display of positive affect. Specifically, this study will test whether repeated voluntary mimicry of the Duchenne smile is an effective way to induce physiological feedback effects (as operationalized by survey responses about mood). Additionally, possible relationships between empathy and accuracy of mimicry will be examined.

Discovery and Measurement of the Duchenne Smile

The French neurologist, G.B. Duchenne de Boulogne, is credited as the first scientist to notice that contraction of the orbicularis oculi muscle during smiling is associated with genuine enjoyment, which he reported in 1862 (Ekman, 2007). Paul Ekman and his colleagues (Ekman, Davidson, & Friesen, 1990) were able to confirm Duchenne de Boulogne's observations experimentally using a tool they developed, a detailed guide to assessing facial muscular movement they called the Facial Action Coding System (FACS). In FACS terms, the smile of genuine enjoyment involves simultaneous activation of action units 6 and 12 (AUs 6 and 12), corresponding to muscle contractions of the orbicularis oculi and the zygomatic major muscles, respectively. Ekman suggested naming this smile the "Duchenne smile" in honor of Duchenne de Boulogne (Ekman, 2007). In contrast, social smiles involve contraction of the zygomatic major muscle only (AU 12 only). Since the Duchenne smile is associated with felt emotion much more than other types of smiles (Ekman, Davidson, & Friesen, 1990), there is reason to believe that more empathetic individuals may be better at mimicking Duchenne displays.

Discovery of Facial Feedback Effects

To create the FACS, Paul Ekman and his coworkers taught themselves how to voluntarily move each independently active muscle group in the face individually and in various combinations in order to learn how to code them accurately (Ekman, 2007). A bi-product of these activities were numerous anecdotal reports about feeling specific emotions while practicing particular combinations of AUs that corresponded to particular expressions—feeling anger after practicing anger-related AUs, sadness after practicing sadness-related AUs, and so forth. The idea that production of facial expressions might actually generate or impact emotions is now usually referred to as the "facial feedback hypothesis" following the coinage of Tourangeau and Ellsworth (1979, page 1521). Strong evidence for the facial feedback hypothesis was provided by Soussignan in his 2002 study. Soussignan discovered that having participants hold chopsticks in their mouths simulated frowns or smiles depending on the position of the chopstick and the instructions given for holding it (e.g. "hold it with your teeth without letting your lips touch it"). In this way, participants maintained specific muscle activations as they viewed video clips. A cover story was used to conceal the role of the chopsticks as expression maintainers, and Soussignan reported that, based on participant surveys, no one had guessed the true purpose of the experiment. The group of participants with simulated smiles rated video clips as more funny and enjoyable than the group who had simulated frowns. The present study will investigate whether repeated voluntary mimicry is another way to induce similar facial feedback effects.

Adaptiveness of Mimicry

McIntosh, Reichmann-Decker, Winkielman, and Wilbarger (2006) make a distinction between two types of imitation: automatic mimicry (imitation that occurs without prompting to do so) and voluntary mimicry (imitation that occurs in response to prompts). Participants in the present study are verbally prompted to make their faces like the faces they see in photographic stimuli, so their behavior in response to these stimuli will be described herein as voluntary mimicry.

Mimicry is an important phenomenon in human interactions (Maringer, Krumhuber, Fischer, Niedenthal, 2011; Hatfield, Cacioppo & Rapson, 1993; Stel & Vonk, 2010). Mimicry of the Duchenne smile may be particularly important in sharing and signaling cooperative intent (Mehu, Little, & Dunbar, 2007; Mehu, Grammer, & Dunbar, 2007). A lack of mimicry, in the case of unreturned Duchenne smiles, has also been found to be maladaptive (McDonald & Messinger, 2012). Thus, there is much evidence to suggest that mimicry behavior is something worth trying to teach to individuals who mimic deficiently in contexts where more mimicry might facilitate higher quality interactions.

Correlates of Duchenne Smile Displays

Display of the Duchenne smile is associated with social (Johnston, Miles, & Macrae, 2010; Mehu, Little, & Dunbar, 2007; Mehu, Grammer, & Dunbar, 2007; Shore & Heerey, 2011; Miles & Johnston, 2007; Reed, Zeglen, & Schmidt, 2012), physiological (Ekman, Davidson, & Friesen, 1990; Soussignan, 2002; Abel and Kruger, 2010) and cognitive (Johnson, Waugh, & Fredrickson, 2010; Fredrickson, 2001) benefits. There is considerable variance in the display of the Duchenne smile, operationalized as simultaneous activations of AU 6 (orbicularis oculi pars lateralis) and AU 12 (zygomatic major), from person to person and across contexts (Ekman, Davidson, & Friesen, 1990).

Empathy, Mimicry, and Duchenne Smiling

Empathy can be defined as "the ability to feel or imagine another's emotional experience" (McDonald & Messinger, 2012, page 1566). One study has found that empathy, as measured by Mehrabian and Epstein's (1972) instrument, is positively associated with spontaneous mimicry (Surakka & Hietanen, 1998). There may be a similar relationship between empathy and voluntary mimicry—this possibility is investigated in the present study.

If Duchenne mimicry facilitates higher quality interactions (Hess & Bourgeois, 2010) then interventions that potentially improve Duchenne mimicry responding should be of interest to researchers and practitioners. The cognitive impacts of Duchenne smile displays cited above (and explained in more detail below), in addition to recent studies that show that mimicry reduces racial prejudice (Inzlicht, Gutsell, & Leagault, 2012), suggest that empathy may also be affected in specific ways by mimicry of Duchenne smiles.

Most studies that investigate the Duchenne smile are correlational (Abel and Kruger, 2010, Harker & Keltner, 2001), but at least one study has assembled large amounts of evidence documenting numerous instances in which positive affect preceded successful outcomes which suggests a possible causal role for such displays (Lyubomirsky, King, & Diener, 2005). Abel and Kruger (2010) were able to take advantage of the massive amount of data available on their research subjects, major league baseball players, to show that the type of smile displayed in photographs (Duchenne or non-Duchenne) predicted significant differences in longevity. The players who displayed the Duchenne smiles lived an average of almost five years longer than those who had displayed partial or social smiles and almost seven years longer than the players who hadn't displayed smiles. Harker and Keltner (2001) also scored photos (yearbook photos) and found that marital satisfaction and personal well-being were predicted by the degree of Duchenne smiling. In Mehu, Little and Dunbar's 2007 study, people made choices about smiling and neutral faces, assigning characteristics to these faces such as generosity and extroversion. When the participants in this study compared neutral faces to faces that displayed a social smile, they rated the social smiles as being significantly lower for generosity and for extroversion compared to the ratings given to faces that displayed Duchenne smiles. This is one piece of evidence that indicates that people will have different responses to the different types of smile involved in this study and suggests that discriminating voluntary responses to the smiles in other forms such as mimicry are not unreasonable to expect.

The Duchenne Smile in Interactions

Mehu, Grammer, and Dunbar (2007) watched people interacting with their friends in a situation in which sharing was required and in another situation in which it wasn't. They found that there were differential rates of Duchenne smile displays among friends in the two different conditions such that Duchenne smiles occurred at significantly higher rates when friends needed to share. This finding points again to the importance of the display of the Duchenne smile in interactions. These researchers called Duchenne smiles, "honest signals of altruistic dispositions" (page 415).

Shore and Heerey (2011) investigated whether genuine and polite smiles would have different values as conditioned social reinforcers during interactions. These researchers offered both social and non-social (monetary) feedback to participants while they were learning contingencies in a game and found that, by comparing how participants learned the contingencies with genuinely smiling versus socially smiling faces, genuine smiles had greater reinforcement value than social smiles. They found that participants' behaviors were altered in systematic ways by Duchenne smile stimuli during the learning of contingencies. By making careful comparisons in the way contingencies were expected to be learned if all stimuli had equal value as reinforcers, the role of the Duchenne smile as a generalized social reinforcer was supported. Since the present study asks one group of participants to perform voluntary mimicry repeatedly in response to Duchenne smiles, reinforcement may occur whenever one Duchenne smile image follows another, as if in response to the previous mimicry attempt (this happens five times). Indeed, Shore and Heerey's work suggests that participants in this group may receive operant conditioning for production of facial expressions that they perceive to be the same as the Duchenne smile stimuli they are responding to.

Hess and Bourgeois (2010) created same sex and mixed sex dyads and observed usage of the Duchenne smile during interactions occurring in different contexts. They found that the display of a Duchenne smile enhanced the quality of participant interactions due to its function as a signal of social intent. Functional usage of Duchenne smiling for men and women was found to be the same across the different kinds of dyads. This indicates that different dyadic patterns with respect to gender in the sequences of experimental events in the present study shouldn't impact results. It also provides more support for the importance of the Duchenne expression for maintaining interactions.

In Miles and Johnston's 2007 study, a functional role of Duchenne smiles (called enjoyment smiles by these researchers, but measured in terms of AUs 6 and 12 using the FACS) in regulating social interaction was also supported when participants were able to use Duchenne smiles but not non-Duchenne smiles to correctly identify words with positive associations during a priming task. Merely seeing the Duchenne smiles helped participants in this study correctly interpret stimuli that followed, while the social smiles appeared to contain no functional value for the task. This supports the decision to include intense social smiles for the control group in the present study as this kind of smile doesn't appear to have positive associations that could alter cognitions. This will be crucial for investigating effects of the Duchenne smile in the present study (the social smiles in the control condition aren't likely to produce cognitive effects and so any possible cognitive effects of the Duchenne smile should stand out more in contrast).

Reed et al.'s (2012) relatively recent study, similar to previously cited work, found that Duchenne smiles in the context of dyadic interaction predicted cooperative decisions. The importance of this work relative to the present study is that even in interactions among strangers who were given a prisoner's dilemma task, participants were able to use the Duchenne smile to successfully signal intent to choose the most cooperative and successful outcome.

Johnston, Miles and Mccrae (2010) also observed participants' spontaneous attention to smile types in situations involving trust and communication. More attention was paid to the Duchenne smiles than the non-Duchenne smiles and participants cooperated more in response to the Duchenne smiles. This study also showed that Duchenne smiling predicted cooperative outcomes.

Mimicry, Mood and Emotional Contagion

Likowski et al.'s (2011) research on mood and mimicry also has a bearing on the present study. Participants in their study were asked to watch film clips that were intended to either lift or depress mood. They were then observed with electromyographic equipment while viewing neutral, sad, angry, and happy expressions. The participants who watched the happy clips spontaneously mimicked all of the facial expressions more accurately than the participants who had viewed the depressing clips, whose facial responses were found to be significantly reduced in comparison. Though the present study begins with mimicry of expressions that could possibly induce depressed mood (Soussignan, 2002), both groups of participants will be subject to these effects and so this is controlled for in the current experimental design. Also, an effort has been made to minimize these potential feedback experiences by making the sadness expression (please see the methods section below) a moderate one. The brevity of the voluntary mimicry responses (ten seconds) also makes strong mood depressing feedback effects for the moderate sadness expression unlikely.

Emotional contagion has been considered to be quite similar to empathy (Mehrabian and Epstein,1972) and, due to the simulated interactive and multiple exemplar nature of the task, the findings of the present study may provide evidence that emotional contagion (as outlined by Hatfield and colleagues, 1993) can be induced in a voluntary manner in addition to automatic processes. As previously indicated, the experimental setup of this study simulates a sequence of positive emotional encounters where voluntary attempts to mimic the Duchenne smile are met with more Duchenne smile stimuli. This scenario roughly approximates interactive encounters where, according to Hatfield and colleagues (1993), physiological feedback from the repeated actions (in their description, initially happening without conscious awareness) leads to contagion, or the feeling that one has “caught” someone else’s emotion, like catching a cold or a fever. This theoretical account could explain any group differences in mood, if they are found. Also, as described in the methods section below, since Mehrabian and Epstein's (1972) measure of empathy will also be used to create a time lag between mimicry and the exit photo, the scores obtained from that instrument will be available for these additional between-group comparisons to assess possible emotional empathy effects.

In 2009, Stel and Vonk investigated how perceptions about whether emotional expressions were genuine or acted affected perspective taking and emotional contagion during mimicry of those expressions. They instructed half of their participants to intentionally mimic one of the characters in a reality television program while the other participants passively viewed the same material. They then asked participants about their emotional states as well as questions that tested how well they understood the events of the film from the perspective of the mimicked actor. They found that emotional contagion had been unaffected by perceptions that the actions were not genuine, but that perspective taking was related to these perceptions such that the more people perceived the actions to have been faked, the less accurate they were when assessing events from the mimicked actor's perspective. The present study will also test for emotional contagion but will differ in that mimicked responses of an expression known to be perceived as genuine (as previously detailed) will specifically be used. Another key difference in the present study is that several different faces will be mimicked rather than a single one and this mimicry won't occur within the context of a surrounding story. Also, the mimicry in the present study occurs in response to static images and the participant won't have any information about the context in which the expressions occurred but may assume, correctly, due to their uniform quality, that they were staged. Nevertheless, Stel and Vonk's (2009) results suggest that this will not impact emotional contagion.

Harker and Keltner (2001) found that, even after controlling for ratings of attractiveness and social desirability, positive emotional expressions in yearbook photos, as rated in terms of FACS coding of the Duchenne smile, predicted better outcomes for marital satisfaction and for reports of personal well-being years into the future. Since these findings merely indicate an association between a voluntary display of the Duchenne smile and positive life outcomes, no causal relationship can be inferred. Nevertheless, if the present study is successful in demonstrating that voluntary production of Duchenne smiles can be influenced by repeated voluntary mimicry, this could provide a way to study causal effects, at least in the short term.

Individuals with autism and Asperger's have been found to display emotions differently in interactions than non-autistic individuals (Dawson, Hill, Spencer & Galpert, 1990) and to be deficient in empathy, which can be defined as "the ability to feel or imagine another's emotional experience" (McDonald & Messinger, 2012, page 1566). McDonald and Messinger (2012) observed toddlers' responses and lack of responses to their parents' distress. They found that a lack of empathetic responding predicted later diagnoses with ASD. Dawson et al.'s (1990) study yielded similar results. Dawson and colleagues found that autistic children didn't make as much eye contact when smiling and didn't return their mothers smiles, and their mothers were also less likely to return smiles.

There is evidence that autistic and non-autistic individuals are equally good at voluntary mimicry of some basic expressions (McIntosh, Reichmann-Decker, Winkielman & Wilbarger, 2006; Oberman, Winkielman, & Ramachandran, 2009). However these researchers did not examine mimicry of Duchenne smiles, which are more difficult to produce voluntarily (Ekman, Roper, & Hager, 1980).

Long term outcomes as indicated by the correlational studies discussed above will not be tested in this study, but short term outcomes will be assessed in the form of a voluntary display of a Duchenne smile after several minutes and without accompanying visual stimuli. Such an outcome could indicate that reinforcement in the form of physiological feedback or in the form of the stimuli themselves was contacted during the experiment.

Finally, as cited above, the Duchenne smile may have cognitive benefits such as broadened cognition. The metaphorical language of broadening and narrowing with respect to cognition is meant to suggest restriction of cognition during particular emotional states for survival purposes (Fredrickson, 2001). For example, when people are angry they might need to devote cognitive resources to tasks such as running or fighting, as opposed to attentional flexibility tasks, and this may have had evolutionary benefits (Fredrickson, 2001). If Duchenne smiling affects cognition systematically, then it is possible that participant responses to verbal requests to smile will also be affected systematically.

Additionally, this will be the first study to explicitly examine possible cumulative causal effects of repeated voluntary mimicry of the Duchenne smile in a controlled way.

Research Questions and Hypotheses

Research question 1: Will participants get better at mimicking the Duchenne smile after making several attempts?

Hypothesis 1: Participants in the Duchenne smile group will get better at mimicry while participants in the social smile group will not.

Research question 2: Is a person's empathetic responding associated with their ability to voluntarily mimic facial expressions?

Hypothesis 2: It is anticipated that the more empathetic a participant is, the better they will be at voluntarily mimicking facial expressions, particularly expressions that are more associated with felt emotions (the anger, sadness, and Duchenne smile expressions in the current experiment).

Research question 3: Is the task of repeatedly mimicking the Duchenne smile a way to induce positive emotional contagion?

Hypothesis 3: The average amount of Duchenne smiling in the final photo set for the participants in the Duchenne smile condition will be significantly higher than the average amount of Duchenne smiling in the final photo set for participants in the social smile condition.

Research question 4: Will there be a cumulative effect of voluntary mimicry of the Duchenne smile on mood?

Hypothesis 4: The Duchenne smile group will report that they are feeling significantly better than the social smile group.

METHOD

This study was approved by the George Mason University institutional review board which authorized the use of digital video and photography. Statements of written informed consent were obtained from all participants.

Participants

Fifty subjects were recruited from the George Mason undergraduate population to participate in this experiment. They were recruited through SONA, the undergraduate psychology research pool. There was one exclusion for impaired vision (corrected vision in the form of contact lenses or glasses was acceptable). The participants ranged in age from 18 to 40 (Table 1). Several participants didn't provide their ages, but, upon inspection of their photos were deemed by the experimenter to be within the same age range. Twenty one of the participants in each group were female and four in each group were male.

Table 1

Participant Demographic Information (with Standard Deviations in Parentheses).

		Percentages (within group):						
Group	Mean age	Male	Female	White	Asian	African American	Middle Eastern	Hispanic
Social	23.39 (4.118)	16	84	33	22	17	17	17
Duchenne	23.00 (4.989)	16	84	37	21	16	11	16

Note. *N* = 50 (25 for each group), however *N* = 18 for the social group for all demographic characteristics except sex, and *N* = 19 for the Duchenne group for all demographic characteristics except sex, due to missing data.

Facial Sample Stimuli

The stimuli were static color images of emotional facial expressions presented in PowerPoint presentations. Most of the stimuli consisted of either Duchenne or social smiles. There were two images of faces expressing sadness and anger. Care was taken to ensure all faces occupied the same area of the screen during presentation (photos were taken from roughly the same distance and were the same size). All participants were asked to mimic the same initial set of four images (presented in a random order for each participant) including a social smile, a Duchenne smile, sadness, and anger expressions. Depending on experimental condition, the rest of the stimuli sequences consisted of either six Duchenne or six social smiles. The author is a certified FACS coder and was able to verify the intensity and topographical accuracy of the expressions when the photos were taken and later when assigning criterion FACS scores to the photos. The nine models who donated their photographs to the study were graduate students. Each model supplied a set of photographs including a social smile and a Duchenne smile against the same background (as illustrated in Table 2). Therefore, the only difference in stimuli (other than the order in which they were presented) was the type of smile seen in the last six photographs—the models and backgrounds were the same across conditions.

Procedure

All participants completed the experiment in the same location—at one of two desks with a computer which faced away from each other in a laboratory space in David King Hall on the Fairfax campus of George Mason University. Participants were randomly assigned to either the Duchenne or social smile conditions (see Table 2 below for the sequence of experimental events in each condition). The experimenter was blind to which condition a participant was in. Upon arrival, participants were given the consent forms and the Brief Mood Introspection Scale (BMIS) and Interpersonal Reactivity Index (IRI) questionnaires to fill out. In a mimicry portion of the experiment, subjects were instructed to try their best to "make your face like the face that you see" each time a face appeared and that they would have ten seconds to do so. The photos to be mimicked were delivered via PowerPoint presentations. The participants were videotaped for their entire response to the PowerPoint presentations. After the mimicry portion of the experiment was concluded, the BMIS was administered again followed by Mehrabian and Epstein's (1972) measure of trait empathy. The PowerPoint presentations that contained the expressions to be mimicked had blank slides in between the slides with the photos and participants were instructed to relax their faces each time they saw the blank slides. Finally, in reference to Harker and Keltner's 2001 finding that people who expressed Duchenne smiles in their yearbook photos expressed greater martial satisfaction and greater well-being years later, participants were asked to "smile as if your George Mason yearbook photo is being taken" (this is the exit photo mentioned in Table 2 below).

The sequences of experimental events are outlined in Table 2.

Table 2

Experimental Setup

Groups	Sequence of Events
Group 1:	BMIS – IRI – BP – {Sad, Angry, D1, S1} – {D2, D3, D4, D5, D6, D7} – BMIS – M&E – EP
Group 2:	BMIS – IRI – BP – {Sad, Angry, D1, S1} – {S2, S3, S4, S5, S6, S7} – BMIS – M&E – EP

{randomized order}; BMIS = Brief Measure of Introspection Scale; IRI = Interpersonal Reactivity Index; BP = baseline photo (relaxed face instruction); D1 = first Duchenne smile image; S1 = first social smile image; M&E = Mehrabian and Epstein empathy measure; EP = exit photo

Neutral expressions were captured from the digital video that was taken during the mimicry portion of the experiment and these were used as a basis for assigning FACS scores to the participant exit photos.

The total time taken to complete the experiment was about thirty minutes which included three and a half minutes spent on the mimicry portion and about 25 minutes spent completing the IRI, the BMIS mood questionnaire, and Mehrabian and Epstein's emotional empathy questionnaire.

Calculation of Mimicry Scores

Facial expression scores were based on (a) activation of action units and (b) the intensities of those activations. These scores were assigned after identification of events, defined by Ekman, Friesen, and Hager (2002) as episodic activations of either single or multiple AUs that reach a peak intensity or apex (page 359). The events selected from the videos of participants were those judged to be closest to the end of every ten second interval in which participants were exposed to photographic stimuli. This gave participants the maximum amount of time to make alterations in their expressions as they attempted to match their faces to the faces in the photographs. A mimicry score was then derived from a quantitative comparison of the FACS score for the apex of a selected event to the FACS score assigned by the experimenter to the model photo that the participant saw at the time the event occurred (the criterion score).

Identification of apex expressions is part of FACS training, and the experimenter was certified to be a FACS coder. AU intensities were rated on a scale from A to E as follows: A = 1, B =2, C =3, D = 4, E = 5, where larger integers represent greater intensity. The quantification of similarity of model and participant expressions was achieved by using a modified version of Harker and Keltner's (2001) additive method of scoring. The modifications were the addition of penalties for overextending AUs beyond the level of intensity present in the model photograph being imitated and also for the extent of AUs present that were not present in the model photographs. Not including an

AU in imitation that was present in the model photograph did not result in a penalty but would nonetheless score lower. Higher mimicry scores represented a relatively (compared to other participants) higher degree of accuracy. For example, if the criterion score for the model photograph included only AU 6 and AU 12, then a participant who also displayed AU 20 would have his or her mimicry score lowered to the extent that AU 20 was present. The mimicry scores for participants in the Duchenne condition were therefore higher than those in the social smile condition. The model photos for the social smile condition contained only AU 12, with a range of intensity from 12B to 12D, while the model photos for the Duchenne condition contained AU 6 in addition to AU 12 and also sometimes AU 25 and AU 7. AUs 25 and AU 7 often co-occur with AU 6 during Duchenne smiling (Ekman, Friesen & Hager, 2002) and so could not be eliminated from the model photos. The nature of the mimicry task necessitated taking all AUs present in model photographs into account in the scoring. Extent of Duchenne smiling was operationalized as extent of AU 6 activation contingent upon the presence of at least some AU 12 activation. As previously mentioned, when a particular AU was present in an instance of participant imitation but its rated intensity exceeded the criterion level of intensity, the score was reduced by the extent of the excess intensity (subtracting the integer value of excess from the overall score). For example, two people may wind up with the same score, even if one person was not intense enough and another was too intense. For example, if the first person had a 7B instead of a 7C s/he would be scored a 2 on that AU. If the second person had a 7D instead of 7C, they would receive 3-1 = 2 points (three for getting up to 7C and then subtracting one for going beyond that to 7D).

One last example will illustrate all of the components of quantifying accuracy of mimicry using this method: Let 5C + 6D + 12D + 25D be the FACS score given to the expression of the model in the photograph being viewed and let 1C+ 6D +12C+ 25E be the FACS score given to the apex in the event that was selected out of the entire imitative response to that model's expression. The participant did not display AU 5, which is present in the criterion score, so they receive a 0 for that AU. Next, since AU 1 is not present in the criterion score but it appears in the apex FACS score this results in a penalty that reflects the full extent of intensity (the negation of C =3 is -3, which is added to the total score). AU 6 is present in both the criterion score and the participant's apex FACS score, and the participant's extent of activation does not exceed the criterion extent of activation, so 4 (D =4) is added to the overall score. Next, AU 12 is present in both the criterion score and the apex FACS score, but the participant's apex intensity is less than the criterion intensity—they receive C = 3 points, but they could have received 4 points if their intensity level had the matched the D-level criterion intensity. Finally, AU 25 is present in the criterion score and in the apex FACS score, but the participant has exceeded the extent of criterion activation by one level and is thus penalized one point and so 4 + -1 = 3 is added to the total. According this method, the accuracy of mimicry (the mimicry score) will be equal to 0 + -3 + 4 + 3 + 3 = 7.

The social smile stimuli had an average maximal (ceiling) score for accuracy of 3 (with criterion scores ranging from 12B = 2 to 12D = 4) while the Duchenne group had an average maximal score of 11.5 (with criterion scores including a range of intensities from 6C to 6E and sometimes including AUs 25 and/or AU 7 at various intensity levels).

The highest possible score (the highest ceiling score) for the social smile group was 4 (for perfectly mimicking a photo with a criterion score of 12D) and the highest possible score for the Duchenne group was 13 (for getting a perfect 12D + 6E + 25D). The lowest ceiling score for the social group was a 2 (responding to stimulus with a criterion score of 12B), while the lowest ceiling score for the Duchenne group was a 10 (responding to a stimulus with a criterion score of 12D + 6D + 7B). A perfect mimicry score was awarded to a response only when the criterion FACS score exactly matched the FACS score for the response. All FACS scores and ceiling scores for the last six time points are listed below in Table 3.

Table 3

Criterion scores for model photographs (last six time points)

	Social condition			Duchenne condition	
Photo set	Criterion Score	Ceiling score		Criterion Score	Ceiling Score
1	12C	3		6D + 7B + 12D	10
2	12C	3		6D + 7B + 12D	10
3	12B	2		6D + 7B + 12D + 25C	13
4	12D	4		6C + 12D + 25D	11
5	12D	4		6E + 12D + 25D	13
6	12B	2		6D + 12D + 25D	12

Note. A different model was used for each set (one social smile and one Duchenne smile) of photos. As described above, photos, within condition, were delivered randomly. Ceiling scores are the quantification of the criterion score and represent a perfect or maximal score.

Measures

The *Interpersonal Reactivity Index* (IRI) was chosen to measure empathy due to its multidimensional nature (Davis, 1983), which has been found to reflect aspects of autism (Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007) in its measurement. Davis created this instrument to tap into four aspects of empathy he felt were relatively independent: empathic concern, fantasy, personal distress, and perspective taking. Each of its subscales, which address each aspect of empathy separately, has seven Likert-type questions that ask participants to indicate how strongly a self-statement applies to them (ranging from 1 to 5 where 1 represents "does not describe me well" and 5 represents "describes me very well"). For example, a participant will be asked how strongly the statement, "I often have tender, concerned feelings for people less fortunate than me," represents them. The overall scale ranged from 0 to 140. Each of the four subscales ranged from 0 to 35. Specific predictions have been made with respect to two subscales of the IRI, empathic concern and personal distress, as these have been shown to distinguish between individuals with Asperger's syndrome and control participants (Rogers et al., 2007).

The *Brief Mood Introspection Scale* (BMIS), which was developed by Mayer and Gaschke in 1998, features sixteen Likert-type questions with four choices each that asks participants to rate how well various mood-related adjectives apply to them. For example, participants are asked to assess how "lively" they feel (responses ranging from 'XX' indicating "definitely do not feel," to 'VV' indicating, "definitely feel"). The BMIS scale ranged from 6 to 74, with higher integers representing more positive mood.

The *Mehrabian and Epstein empathy measure* is a trait measure of empathy that was developed in 1972. It features thirty three statements where participants rate (from -4 to +4, including 0) how well the statement applies to them where greater integers represent a greater applicability of the statement. The scale of this measure ranged from -132 to +132, where greater integer values represent higher trait empathy.

Equipment

A MacBook Pro laptop with retina display and an HP laptop with a high definition display were used to deliver images via PowerPoint presentations to participants and to capture digital video of their mimicry attempts. A Panasonic digital camera was used to obtain the exit photos.

Data Analyses

To determine whether people in the Duchenne group got better at making the Duchenne smile more than the Social Smile group, a two-way mixed ANOVA was proposed to assess whether mimicry score means for the Duchenne group (i.e., D2-D7) changed differently over time compared to the mimicry score means for the social smile group (S2-S7). However, due to non-normal data, Friedman ANOVAs were performed for each group. Friedman ANOVAs were also used (again, due to non-normal data) to assess possible changes in expressed AU 6 intensity alone over time.

To determine whether a person's self-reported empathy was associated with their ability to voluntarily mimic facial expressions, Pearson correlation coefficients were calculated between empathy subscale scores (i.e., empathic concern and personal distress subscales of the IRI) and mimicry scores for sadness (Sad), anger (Angry) and happiness

(D1). Since mimicry scores for sadness, anger and happiness were not significantly intercorrelated (Table 3), it was not reasonable to interpret a sum of those scores as a quantification of general skill at voluntary mimicry of emotional expressions.

To determine whether the task of voluntarily mimicking the Duchenne smile induced a positive mood two sets of analyses were conducted. First, mean amounts of Duchenne smiling present in the exit (EP) photo were calculated for each group and the averages were compared using a between-groups *t* test. Second, Post-BMIS scores were compared via a *t* test (no significant differences were present in BMIS scores initially between the groups). Additional relationships between empathy and change in mood (ΔBMIS) were examined by calculating Pearson correlation coefficients for the social and Duchenne conditions independently.

RESULTS

The mean time from onset of photographic stimuli to apex expressions was calculated to be approximately 5 seconds (*M* = 5.058, *SE* = .193). This response time reflects how many participants adjusted their expressions as they studied the photos. It should also be noted that participants did not necessarily hold the apex expression for the remainder of the ten second interval in which they saw stimuli photographs. Differences in mean time from onset of stimuli to apex expressions between groups approached significance, with the Duchenne group taking less time (*M* = 4.71 , *SE* = 1.25) than the social group (*M* = 5.40, *SE* = 1.42), $t(48) = -1.83$, $p = .073$. This result was unexpected, since the Duchenne smile involves more AU activations than the social smile.

No significant changes in overall mimicry over time were found. Friedman ANOVAs were used to look at changes in each group over time. Neither group changed significantly over the last six time points: $X^2(5) = 6.04$, $p > .05$ for the social group, and $X^2(5) = 4.98$, $p > .05$ for the Duchenne group The social smile mimicry score group means ranged from .760 to 1.56 (25 to 50 percent accurate relative to the average criterion score of 3) and the Duchenne group ranged from 6.24 to 7.24 (54 to 63 percent accurate relative to the average criterion score of 11.5). As mentioned above, mean scores for the two groups differed substantially as a consequence of the relative numbers of AUs involved: the social smile group needed only to mimic AU 12, while the

Duchenne group needed to mimic AU 12, AU 6 and sometimes AUs 7 and 25 which occurred naturally with the expression of AUs 12 and 6 in some of the photos used as stimuli. The social smile group average mimicry score rose from 0.76 to 0.84 from the first to the final attempt, while the Duchenne group average decreased from 7.24 to 6.60.

Friedman ANOVAs were also used to look at changes in each group over time with respect to extent of AU 6 activation alone in the last six time points. While the social group did not change significantly, $X^2(5) = 7.688$, $p > .05$, the significance of the Friedman ANOVA for the Duchenne group, $X^2(5) = 13.730$, $p = .017$, indicated that Wicoxon signed rank tests should be used to assess significant change in AU 6 activation, for the Duchenne group. The largest change in AU 6 activation, which occurred from the first mimicry attempt in the subsequence of consecutive attempts to the third (time point 5 to time point 7), demonstrated a significant decrease (*Mdn* decreasing from 3 to 2), $z = -2.26$, $p = .024$, $r =-.32$, in AU 6 activation for the Duchenne group. The second biggest drop in AU 6 activation (*Mdn* decreasing from 3 to 2) for the Duchenne group, from the first mimicry attempt in the consecutive Duchenne smile subsequence to the last (time point 5 to time point 10), approached significance, $z = -1.78$, $p = .075$, $r = -.25$.

Self-reported empathy and mimicry ability as measured by anger, sadness, and happiness mimicry scores were found to be uncorrelated. The anger, happiness, and sadness scores were not significantly intercorrelated (Table 4) and only sadness and happiness mimicry scores were significantly correlated with other variables of interest. Empathic concern and personal distress IRI subscale scores were uncorrelated with accuracy of anger, sadness, and happiness expressions. The social group (*M* = 46.30, *SE*

= 4.26) did not differ significantly from the Duchenne group (*M* = 46.98, *SE* = 4.53) on the Mehrabian and Epstein (1972) measure of trait empathy, $t(48) = -.109$, $p = .931$ = n.s.

Table 4

Correlations Among IRI Subscales and Emotional Facial Expressions

	EC	Sadness	Anger	Happiness
Personal distress	-.093	-.269	.078	-.161
Empathetic concern		-.014	.059	.073
Sadness			.188	-.031
Anger				.019
Happiness				

EC = Empathic Concern subscale score
***Note:* All *p*s are non-significant.**

Voluntary mimicry of both social and Duchenne smiles was followed by significant mood increases, but the increase for the Duchenne condition was not significantly greater than the increase for the social condition. The first *t* test comparing initial average mood between the social group (*M* = 54.480, *SE* = 1.842), and the Duchenne group (*M* = 54.840, *SE* = 1.410) yielded non-significant results, $t(48) = -.155$, $p = .877$ = n.s. A similar non-significant result was found when the final mood of the social group (*M* = 57.360, *SE* = 1.642) and the Duchenne group (*M* = 58.90, *SE* = 1.072), $t(48) = -.785$, $p = .436$ = n.s.), were compared. However, it should be noted that both conditions had significant increases in self-reported mood: $t(24) = 2.69$, $p = .013$ for the social group and $t(24) = 4.76$, $p < .001$, for the Duchenne group. The social condition increased their reported mood by 5.3% and the Duchenne group reported an average increase of 7.4%. However, without a significant difference between the group final mood scores and without more comparison groups to provide a basis for inference, it isn't possible to attribute the increase in mood to mimicry of a particular type of expression or even the mimicry portion of the experiment.

Exit photo comparisons. An independent *t* test revealed that mean Duchenne smiling in the Duchenne condition ($M = 2.08$, $SE = .341$) was not significantly different from mean Duchenne smiling in the social condition ($M = 1.80$, SE = .306, $t(11) = -.611$, n.s.).

An unexpected result was a significant negative correlation of self-reported empathic concern with ΔBMIS in the social smile condition ($r = -.505$, $p =.01$) but not in the Duchenne condition where the correlation was non-significant ($r = -.266$, $p = .198$ = *n.s.*). Sadness mimicry scores were not significantly correlated with empathic concern ($r = -.014$, $p = .923$ = *n.s.*). However, sadness scores, just as empathic concern scores, were significantly negatively correlated with ΔBMIS ($r = -.455$, $p < .05$) in the social group but not in the Duchenne group (*r* = -..142, $p = .498$ = *n.s.*). The exit photo score was significantly positively correlated to the happiness mimicry score for both groups of participants ($r = .383$, $p < .01$). For all participants, the extent of Duchenne smiling, as operationalized by the total extent of activation of AU 6 in the apexes of the mimicry attempts was significantly positively correlated with self-reported mood at the second time point ($r = .278$, $p < .05$).

DISCUSSION

This study sought to examine the possible impact of repeated mimicry of Duchenne smiles on mood and also to determine if empathy was related to accuracy of voluntary mimicry of different emotional facial expressions.

It was proposed above, based on Shore and Heerey's (2011) work, that the Duchenne smile stimuli may function as reinforcers while social smile stimuli do not, and that repeated exposure to Duchenne smiles following attempts to mimic might increase a participant's chances of exposure to facial feedback effects via reinforced attempts to mimic, and that this might be a mechanism for increasing accuracy and for increased mood. However, if the first smile in the repetition subsequence, as illustrated in Table 2, is inaccurate (it was only 63% accurate relative to the average criterion score for the last six time points), then reinforcement may have resulted in an increased likelihood of subsequent performance of the initially inaccurate behavior. Since a large amount of variance and error in initial attempts to mimic a Duchenne smile was observed in this study, this may explain why no improvement was found and mimicry scores remained at the same levels throughout the sessions.

Participants also made a large number of "mistakes" in the social smile condition where many people responded to social smiles with Duchenne smiles. These mistakes may have been due to a lack of discrimination among these types of smiles or they may have reflected amusement during, or enjoyment of, the mimicry task. Either way these Duchenne smile mistakes may have contributed to the mood increase for the social group through facial feedback effects. Or, it could be that activation of the zygomatic major muscle group (AU 12) independently contributes to facial feedback effects in addition to contributions from AU 6.

Behavior in response to verbal requests to smile is different than smiling in response to someone else smiling. Habitual responses to verbal stimuli of the kind used to prompt expressions in the exit photo of this study may operate relatively independently of mood. Therefore, even if a participant did experience facial feedback effects, these kinds of mood enhancing effects don't necessarily override extensive learning histories regarding "posed" smiles which, in the absence of awareness of differences between types of smiles or even in spite of those awarenesses, may persist unless other conditioning intervenes.

The significant decrease in activation of AU 6 in apex expressions that was found for the Duchenne smile group may reflect the difficulty of forcing that muscle group to be active or discomfort at holding a Duchenne smile for an abnormal length of time.

Limitations

In the Duchenne group participants may have experienced mild discomfort. Hess and Kleck (1990) documented a range of .5 to 4 seconds of duration for Duchenne smiles, which contrasted with longer and shorter durations of non-Duchenne smiles during naturalistic observations of their subjects. Since the time allotted to mimic an expression in this experiment was ten seconds, depending on how quickly and accurately an expression was mimicked, participants in the Duchenne condition may have held their expressions for an abnormally long time.

Movement is another key aspect of emotional interactions that was not addressed by this study. Interpersonal interactions involve intricate transactions of emotional display that are not possible to duplicate simply by asking people to make their face like the faces they see in a sequence of photographs.

More in-depth assessment of emotional facial expressions throughout the experiment may illuminate other sources of error. For example, numerous emotional expressions immediately following mimicry attempts including expressions of undoing (microexpressions of contrary emotional expressions including contempt and other negative emotions) were noted among many of the study participants. Additionally, many of the participants were observed to have strong displays of positive affect immediately following the exit photo. Later these participants were identified as having participated in the Duchenne condition. However, without rigorous application of measurement of affect following the exit photo that observation is merely anecdotal.

The use of only one person to code the mimicry responses is a weakness of the present study. Though the experimenter is certified as a FACS coder, it would have made the mimicry scores more robust to use an average score among a small group of certified FACS coders working independently and blind to the purposes of the experiment. Mimicry scores were not calculated blind to condition or to the sequence of repeated imitations which may have introduced bias into the calculations involving change in mimicry accuracy over time.

It is possible that other methods of coding accuracy of mimicry using FACS scores would yield different results. For example, ignoring excesses in AU activation or ignoring intensity of AU activation altogether are other possibilities.

Future directions

The empathic concern subscale's significant negative correlation with mood change in one experimental condition and not the other should be examined further. It is unclear why empathic concern predicts reduced mood increases when participants repeatedly mimic social smiles but not when they repeatedly mimic Duchenne smiles.

Also of note was the significant negative correlation between the sadness mimicry score and change in mood only in the social smile condition. One possible explanation is that successful mimicry of the sadness expression and concomitant facial feedback effects offset Duchenne smile mistakes made when mimicking the social smiles.

The accuracy of voluntarily mimicking a Duchenne smile in a photograph was found to be significantly positively correlated with production of a Duchenne smile in response to a verbal request. Future experiments should try to establish whether there is any causal relationship between ability to mimic Duchenne expressions (which could perhaps be manipulated with training) and relatively stable increases in reported mood.

Use of alternate behavioral measures of mood such as examination of responses to identical video clips (similar to the approach taken by Soussignan, 2002) or measurement of displayed affect in extended interactions with other people following the mimicry attempts may better capture the extent of any effect of voluntary mimicry of different types of expressions on mood changes, if they exist.

Instead of using photos, more dynamic tasks of trying to mimic changing facial expressions on video could be used. As previously mentioned, it might also be better to use stimuli that are roughly the size of an actual face to better simulate a real interaction.

Future research should include more control groups to clarify which aspects of the experiment were responsible for the mood increases.

More research is also necessary to determine how long enhanced mood is sustained following mimicry and other indirect measures of mood (along of the lines of Soussignan, 2002) should be used so that more contextual variables come into play before mood is assessed. Particularly important would be to assess positive affect by measures other than self-report including physiological responses and other behavioral measures of positive affect following the experiment.

Future studies could also include brain scan technologies to investigate possible spreading activation of particular areas in the brain in response to the repeated exposure to stimuli and subsequent attempts to mimic. For such a study, a comparison group that passively viewed the stimuli could provide a useful contrast. However, the present study did not demonstrate that there are indeed effects of voluntary mimicry of the Duchenne smile specifically.

Some important aspects of the Duchenne smile which were not investigated in this study were symmetry in expression and simultaneity of apex actions of independent muscle groups. Ekman and Frank (1993) reported that Duchenne smiles have dimensions of smoothness in their expression and are characterized by simultaneous action of the orbicularis oculi and zygomatic major muscles which culminates in a simultaneous achievement of maximal contraction. Some of the video examples in the facial action coding system demonstrating simultaneous activations of AUs 6 and 12 show asynchronous activations--versions of these asynchronies did occur during the experiment but were not be analyzed. Future studies could address these pertinent issues regarding simultaneity of action of AUs 6 and 12 and smoothness of motion as the smiles are displayed.

Assessment of mimicry accuracy may soon be facilitated by automated computer scoring. This would also better facilitate the use of all emotional expressions present in video as scoring would be instantaneous and much less cumbersome and time consuming and also quantities over intervals would be possible to calculate and these may be better to use for predictive purposes.

Conclusion

Repeated attempts to mimic Duchenne smiles without feedback are unlikely to lead to improved accuracy of such mimicry. Rather, it appears that shaping interventions would be necessary for a person to learn how to display a Duchenne smile accurately in response to Duchenne smiles.

The present study is not able to conclude that mimicry of the expressions was responsible for the statistically significant increase in mood reported by the participants. With only two conditions available and no statistically significant differences between the two groups found it is possible that any other aspect of the experiment including repeated relaxation of the face or perhaps responding to the empathy surveys was responsible for the increases in both groups.

Voluntarily mimicking six Duchenne smiles in a row did not impact Duchenne smiling in response to a verbal request. This result points to the use of both shaping and fading procedures if the desired outcome is for participants is to learn how to quickly and accurately display such smiles in dynamic social encounters and in other important social situations such as having photos taken.

Implications

The major implication of this work is that that people need feedback and training to improve their ability to mimic Duchenne smiles. While mimicry of social smiles is relatively easy and perhaps socially benign, the bulk of previously cited research highlights the value of being able to return a Duchenne smile. This study support the notion that people vary significantly in their ability to voluntarily produce these kinds of smiles and it may be difficult for some people to do so simply by looking at another face to mimic.

Future experiments could explore ways in which rewards and visual or other types of guidance might further shape behavior towards more topographically accurate expressions during mimicry attempts (such as a shaping procedure that uses onscreen visual guidance and prompting for example) and increase its rate of occurrence outside of the laboratory. Dimberg and Soderkvist's (2011) research demonstrated that giving participants instructions to move different muscles in their faces in response to stimuli resulted in lasting feedback effects. Specific instructions based on the FACS could be developed to direct participants to topographically accurate expressions of the Duchenne smile. It may be that if groups of individuals who recently experienced facial feedback and reinforcement in response to repeated, accurate Duchenne expressions then interacted with each other in a relaxed setting, emotional contagion would further maintain the behavior. One mechanism of such contagion may be the Duchenne smile's role as a conditioned social reinforcer—Shore and Heerey (2011) found evidence that Duchenne smile displays regulated interactions in a way that is consistent with reinforcement. In the Duchenne smile condition of this study, the mimicry of one Duchenne smile is met with another Duchenne smile in five consecutive cases that occur in a brief amount of time (ten seconds) and so it is possible, if Shore and Heerey are correct, that the mimicry behavior becomes somewhat reinforced during that block of mimicry attempts. It was not possible to examine in the present study, but perhaps, if enough participants who initially make some mistakes in their mimicry or idiosyncratically include extraneous AUs continue to make these mistakes in the Duchenne smile condition, it could indicate that, perhaps, the Duchenne smile stimuli are reinforcing the inaccurate displays and maintaining them. If that is the case, there is a need for additional instructions of the kind mentioned in Dimberg and Soderkvist's (2011) study, or which could be developed from the FACS.

In conclusion, voluntary mimicry of Duchenne smiles isn't likely to be an easy task for many people. The 63 percent accuracy of mimicry of smiles in the Duchenne smile condition found in the present study provides support for Ekman's and colleagues' observations of difficulty in intentional production of Duchenne smiles in their 1990 article. People may be in need of guidance and training to produce these kinds of smiles. Recommendations for future studies include using reinforcement to establish a diverse collection of Duchenne smile stimuli as being rewarding, then implementing a shaping procedure with visually delivered guidance to teach subjects to accurately display Duchenne smiles in response to those stimuli.

APPENDIX

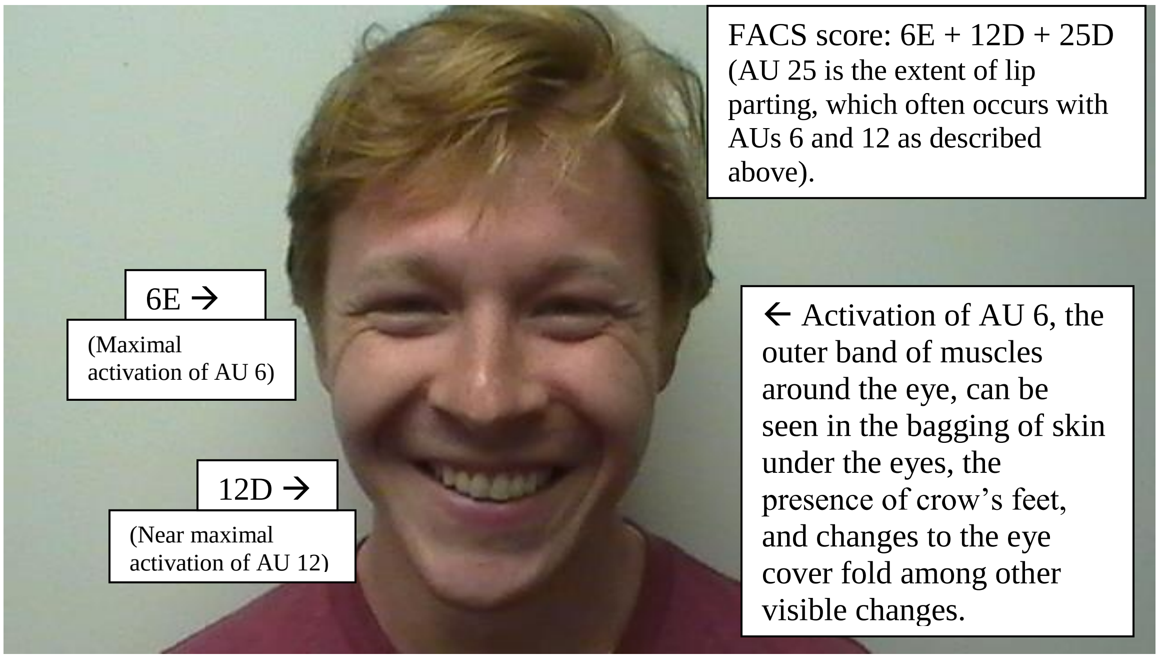

Figure 1. The Duchenne smile

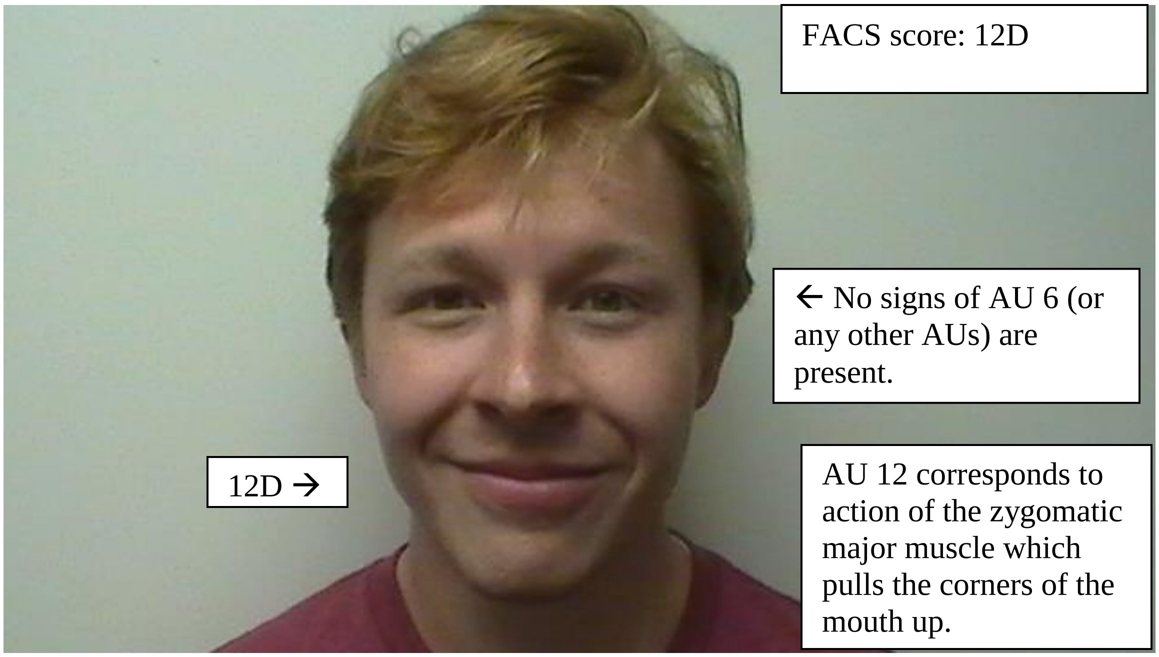

Figure 2. The social smile

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