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The Deliberate Duchenne Smile: Individual Differences in Expressive Control

Sarah D. Gunnery · Judith A. Hall · Mollie A. Ruben

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Abstract We explored the ability to produce deliberate Duchenne smiles and individual differences in this ability. Participants engaged in both a role-play task, designed to measure quasi-naturalistic usage of the deliberate Duchenne smile, and an imitation task, designed to measure muscular capability. In the role-plays, participants were instructed to smile while enacting scripted scenarios, three representing faked positive (masked negative) affect and three representing genuine positive affect. In the imitation task, they were given photographs of Duchenne and non-Duchenne smiles to imitate. Rates of Duchenne smiling provided further evidence that substantial minorities of people have the ability to produce a Duchenne smile deliberately. Individual differences were evident in the consistency in producing deliberate Duchenne smiles across tasks, and in the relationship between deliberate Duchenne smiling and self-reported ability to put on convincing (false) emotion displays in everyday life.

Keywords Deliberate Duchenne smiling · Posing · Individual differences · Expressive control

Introduction

The Duchenne smile, typically called an enjoyment or genuine smile, is often said to be a spontaneous reflection of concurrent positive affect. It is operationally defined in the literature as the activation of the orbicularis oculi (cheek raiser) muscle that makes crow's feet at the outer corner of the eye, called Action Unit 6 (AU 6) according to the Facial Action Coding System (FACS; Ekman et al. 2002), in combination with the zygomatic major muscle that extends the mouth (lip corner puller, AU 12; Ekman et al. 2002).

In the non-Duchenne smile, often called a non-enjoyment, false, fake, or social smile, the eye muscle movement is lacking (Ekman et al. 1990; Frank et al. 1993). Non-Duchenne smiles are widely believed to be under far more volitional control than Duchenne smiles

S. D. Gunnery (✉) · J. A. Hall · M. A. Ruben
Department of Psychology, 125 NI, Northeastern University, Boston, MA 02115, USA
e-mail: gunnery.s@husky.neu.edu; j.hall@neu.edu

(Ekman et al. 1990; Frank and Ekman 1993). The distinction between Duchenne and non-Duchenne smiles can potentially help explain the nature and function of smiling in situations in which concurrent positive emotion may be weak or absent, as in greeting strangers, signaling reassurance, or appeasing powerful others, and in situations in which the expressor is actually experiencing negative affect, as when showing or masking feelings of discomfort, disliking, disappointment, embarrassment, or anxiety (Abel 2002; Ansfield 2007; Ekman and Friesen 1982; Keltner 1995; LaFrance et al. 2003).

The Deliberate Duchenne Smile

Until very recently, the non-volitional nature of the Duchenne smile went unchallenged and, even though a number of studies found that substantial proportions of unselected people could move the relevant muscles deliberately, this was not discussed as a theoretically important finding (Ekman and Davidson 1993; Levenson et al. 1990; Schmidt et al. 2006; Smith et al. 1996). Hess and Bourgeois (2010) found that participants narrating a time they felt angry spent a high proportion (.58) of time producing a Duchenne smile, providing evidence that the Duchenne smile can be produced in the absence of felt positive affect, but it was not possible to ascertain whether those smiles were deliberate. Studies of actors also found high percentages of Duchenne smiling under posing conditions (Carroll and Russell 1997; Gosselin et al. 1995). Only the very recent studies by Krumhuber and Manstead (2009) and Gosselin et al. (2010) have empirically measured the deliberate Duchenne smile and discussed it as a noteworthy phenomenon.

There are several reasons why such a phenomenon has theoretical importance. One is that it has implications for the evolutionary account of facially expressed emotions (Matsumoto et al. 2008). The presence of an emotional display that is involuntary and has a single meaning fits well with a strong version of the evolutionary account, while its absence removes one of its evidentiary building blocks. A second reason is that the existence of the deliberate Duchenne smile opens the door to investigations of its social functions and its possible role as an individual difference related to social skill and other personal characteristics.

In the present study, the deliberate Duchenne smile was investigated using a laboratory paradigm in which expressors were asked to smile in role-plays to convey different social messages, as well as to imitate photographed Duchenne smiles. By measuring deliberate Duchenne smiling across different tasks, as well as by relating deliberate Duchenne smiling to individual characteristics, we moved beyond the question of whether people can produce it to asking when they produce it and who can produce it.

There are good reasons why people might want to use the Duchenne smile deliberately. Research shows that people have insight into the nature, message value, and social utility of the Duchenne smile. Naïve observers, even children age 9–10, attribute more happiness to Duchenne than non-Duchenne smiles (Frank et al. 1993; Gosselin et al. 2002); observers also have more favorable emotional reactions to people showing the Duchenne smile (Surakka and Hietanen 1998) and attribute more desirable characteristics to them (e.g., likeability, competence) (Frank et al. 1993; Woodzicka 2008). Observers also find such expressions to be more authentic and intense (Mehu et al. 2012). Furthermore, people often have insight into what distinguishes Duchenne from non-Duchenne expressions; in two studies, approximately half of the adult observers reported using the expressor's eyes as a guide to making their judgments (Frank et al. 1993; Gosselin et al. 2002). Thus, research shows that people understand both what the Duchenne smile consists of and why it would be advantageous.

Production of the deliberate Duchenne smile may also serve the intrapersonal functions of mood enhancement (Soussignan 2002) and emotional self-regulation (Papa and Bonanno 2008). These are additional reasons why people may grasp the adaptive advantages of being able to produce such a smile when they want to.

The fact that not everyone can produce a deliberate Duchenne smile is consistent with evidence pointing to individual differences in expressive control (e.g., Berenbaum and Rotter 1992; Zuckerman et al. 1975). But having the ability to produce a Duchenne smile deliberately does not necessarily translate into using it in one's daily life. That is because, in any given situation, motivational factors likely play a part. If using a deliberate Duchenne smile means that one is trying to hide one's emotions, or convey a positive message that is not matched at the moment by corresponding emotion, this could be a reason either to want to do it or to eschew doing it, depending on the expressor's personal values and goals in the communication situation. In this respect, the deliberate Duchenne smile is no different than any other deliberate nonverbal display.

The Present Research

In the present study, we addressed the question of how often people produce Duchenne smiles willfully in a laboratory situation—on their own initiative while posing expressions relevant to different social situations and without being explicitly told to make them. This research therefore adds a social dimension to the evidence reported earlier suggesting that quite a few people can move the relevant muscles on command, and it moves closer to finding out how people actually use Duchenne smiles in social interaction. We also gathered naïve perceivers' judgments of how genuine (as opposed to false) the smiles looked, and we investigated individual differences in Duchenne smiling.

We examined gender differences but without making any strong predictions. It is well established that women have more expressive faces than men under both posed and spontaneous conditions (Hall 1984; Kring and Gordon 1998), and Berenbaum and Rotter (1992) found that women could imitate facial expressions more successfully than men could, though Duchenne smiling was not specifically studied. Some studies have found that women show more Duchenne smiling than men do (e.g., Hecht and LaFrance 1998; Hess and Bourgeois 2010), yet these studies could not distinguish between deliberate and spontaneous behavior. Therefore, gender was examined in an exploratory fashion.

In the current study participants posed smiles to a camera under circumstances intended to minimize the occurrence of genuine positive emotion. Participants were instructed to smile while sending three messages describing masked negative affect (e.g., covering up disappointment) and three messages involving genuine positive affect (e.g., happy occasion with friends). Control scenarios were interspersed that described non-happiness related situations (e.g., unmasked disappointment).

Because a key goal was to examine participants' capacity to produce Duchenne smiles deliberately, the experimental procedures were designed to minimize both emotional and motivational factors. Participants were asked to pose, in quick succession, expressions representing wide variation in valence and specific content, thus making it very unlikely that participants would be experiencing different actual emotions from trial to trial. In addition, if participants were able to produce Duchenne smiles while imagining covering over negative feelings with a smile, it would further argue against the possibility that their smiles were spontaneous readouts of concurrent enjoyment. However, to reduce emotional-motivational factors even further, we added a task in which participants were given photographs of a person smiling (AU 12), with and without AU 6 activation, and were

simply instructed to imitate the expression as exactly as they could. Thus, we specifically wanted to measure use of the deliberate Duchenne smile in a more naturalistic context than done in previous studies through the use of role-play scenarios, and to compare that with Duchenne smiling rates while imitating. We also examined whether naïve judges rated the deliberate Duchenne smiles as more genuine in appearance than non-Duchenne smiles.

We hypothesized that a sizeable minority of participants would deliberately produce a Duchenne smile during the role-play tasks, and that there would not be a difference between the amount of Duchenne smiling when role-playing "genuine" and "fake" happiness, as participants would have to deliberately put on the expression in both types of role-plays. We also hypothesized that a higher percentage of people would produce a Duchenne smile when imitating the Duchenne smile than when role-playing the different scenarios because imitating an expression does not require contextual knowledge about facial expressions.

The present study also aimed to explore individual differences, by asking whether there is evidence of reliability in this ability and whether it correlates with individual-difference variables such as self-reported ability to produce expressions when not feeling the relevant emotions and the participant's gender. In terms of individual differences, we hypothesized that there would be consistency across tasks in that participants who deliberately produced the Duchenne smile in one task (e.g., "genuine happiness" role-plays) would be more likely to smile in the other tasks (e.g., "fake happiness" role-plays, and imitating both types of smiles). Due to the new nature of research on the deliberate Duchenne smile, our hypotheses for the relationships between self-reported characteristics and values and use of the deliberate Duchenne smile were much more exploratory. If participants differed in their ability to produce a deliberate Duchenne smile, it seemed possible that those who could do it would be aware of their skill to the point where they could self-report their use of it in everyday life.

Method

Participants

Participants ($N = 105$; 50 men, 55 women) were recruited from Introductory Psychology classes at Northeastern University in partial fulfillment of course requirements. No demographic data besides gender were gathered. Due to technical problems with the video recording, data from nine participants were removed, leaving a final sample of 96 (49 men, 47 women). An additional 49 students (19 men, 30 women) who were recruited in the same manner viewed the participants' expressions in later sessions.

Role-Play Task

Participants were instructed to pose a facial expression for each of 11 scripted role-plays to a video camera with the experimenter present. On six of these, participants were instructed to smile; of these smiling role-plays, three described role-plays where the smiles would be "fake" smiles of happiness (smiles that masked underlying feelings of fatigue/irritation, disappointment, and disliking of another person), and three described role-plays where the smiles would be, in real life, "genuine" smiles of happiness (happy making plans with friends, happy greeting a friend, and happy over a good grade) (see "Appendix" for complete wordings). The remaining five (control) role-plays did not describe or request smiling and were intended, by their nature, to be irrelevant to the smiling theme (all implied a degree of negative affect) while still calling for the use of facial expressions

(genuine sympathy, fake sympathy, sarcasm, genuine worry, and fake worry). The six smiling role-plays were mixed with the five control role-plays so that no two smiling role-plays were adjacent. All participants posed the role-plays in the same order.

All expressions were directed at a video camera that was in plain sight. For each role-play, the context and the participant's intended emotional state were described to the participant, and the participant was given an appropriate sentence to say. An example of a "genuine happiness" smiling role-play was, "You are feeling happy. You are together with your best group of friends. One of them suggests going out to a great new club. You smile and say, 'That's a great idea!'" In both the fake and genuine happiness smiling role-plays, participants were explicitly told to smile.

Imitation Task

The photographs that the participants were asked to imitate came from Ekman and Friesen (1976). In the photographs, one woman and one man posed both a Duchenne and a non-Duchenne smile. The photographs were constructed so that the same lower half of the face was shown in both photographs while the upper half of the face either had AU 6 activation or a neutral upper face. There was no visible evidence of splicing of different upper halves onto the same lower half. Both the Duchenne and non-Duchenne photographs were presented to the participant on the same page so that they could easily see the differences between the two photographs.

Post-experimental Questionnaire

To explore possible correlates of deliberate Duchenne smiling, participants filled out six self-ratings on 1–9 rating scales pertaining to (1) their overall expressiveness, (2) their previous acting experience, (3) how well they thought they did at posing the expressions overall, (4) how convincing they thought they were in the role-plays where they were masking an emotion they did not want others to know they were feeling, (5) whether they thought it was okay to put on false facial expressions in daily life, and (6) how good they thought they were, in general, at putting on facial expressions that would make people think they were having emotions that they were not having. These questions were designed to capture personal characteristics that might be correlated with deliberate Duchenne smiling. In addition, to ensure that more Duchenne smiling was not an artifact of greater effort, a self-rating of effort was also included. Producing a Duchenne smile when imitating the Duchenne smile was marginally correlated with self-reporting trying harder, $r(94) = .19$, $p = .07$. Producing a Duchenne smile in the "genuine" and "fake" happiness role-plays and while imitating the non-Duchenne smile was not correlated with effort, $ps > .68$.

Procedure

Participants were tested individually, and were told that we were interested in looking at how people make facial expressions when they are deliberately trying to do so. The experimenter, who was blind to the study's hypotheses, explained that the participant would be video recorded and obtained consent for the use of the videotapes. The experimenter then explained the role-play task, instructing the participant to read through the description and the sentence and then, when sure of the sentence, to look up into the camera and say the sentence while making the instructed facial expression if relevant.

After two practice role-plays, in which the participant posed surprise and disgust, the experimenter asked if there were any questions. Participants then went through the real trials at their own pace. After all 11 role-plays were completed, the experimenter stopped the video camera.

Next, the experimenter explained that the participant was now to imitate the facial expressions in two photographs in front of the video camera. Participants were randomly assigned to imitate the woman's or the man's expressions. As described above, the photographs showed the same individual posing a broad smile (AU 12), with or without AU 6 activation. The experimenter explicitly pointed out the difference between the two photographs, saying that in the first photograph the person was not smiling with his or her eyes while in the second photograph he or she was, as could be seen by the crinkles around the eyes. The experimenter then turned the camera back on and asked the person to do the first expression (imitate the non-Duchenne photograph). After 5 s the experimenter asked the participant to do the second expression (imitate the Duchenne photograph). Following 5 s of the second expression the experimenter turned off the camera and gave the participant the post-experimental questionnaire. Once the participant had completed the post-experimental questionnaire, he or she was debriefed.

Measurement of Smiling

Two certified FACS coders did the facial coding, maintaining strict adherence to the latest coding criteria for coding AU 6 when AU 12 is of high intensity (Ekman et al., 2002).[1] The videos were coded without audio content to minimize the possibility for bias in the coders. Each certified coder coded each expression independently. If there was a disagreement on any codes then the two coders watched the clip again together and came to an agreement on whether the muscle movement was absent or present. If the coders could not resolve discrepancies in this fashion it was randomly decided which code to use. This assured the results were not skewed by a slight bias in either coder, and was necessary on approximately 2 % of the coded expressions. Intensity was measured using the FACS A-E scale. To enable the correlational analysis of intensity, the letter ratings were coded numerically as follows: A = 1, B = 2, C = 3, D = 4, and E = 5.

Duchenne smiling was defined as the joint occurrence of AU 12 and AU 6 (Ekman et al. 2002). In all analyses of the smiling role-plays, participants who did not use AU 12 (i.e., those who did not smile) for a given message were omitted, so that "Duchenne smiling" always refers to the production of the Duchenne smile given that the person smiled (i.e., proportion of smiles that were Duchenne). The mean AU 12 intensity rating was 2.74 (SD = .72) for the six smiling role-plays, 2.80 (SD = .80) for the "genuine happiness" smiling role-plays, 2.69 (SD = .83) for the "fake happiness" smiling role-plays, 3.35 (SD = .97) for the imitated non-Duchenne photograph, and 3.89 (SD = 1.00) for the imitated Duchenne photograph.

[1] Smiles were only coded for the presence of AU 6 and AU 12. Other smile characteristics such as symmetry and duration were not included as part of our analyses. These characteristics do offer information that perceivers use to differentiate between posed and spontaneous smiles (Krumhuber and Kappas 2005; Gosselin et al. 2002). Not including this information could be seen as a limitation of the current study, but its exclusion is warranted because our interest was whether participants could produce deliberate Duchenne smiles that differed from non-Duchenne smiles, not deliberate Duchenne smiles that are the same as spontaneous Duchenne smiles.

Naïve Viewers' Genuineness Judgments

In groups of 8–10, the 49 naïve viewers watched video of all the smiles. The videos were edited so that each clip began with the participant beginning to read the sentence or at the onset of the expression (whichever came first) and ended when the participant finished the sentence or at the offset of the expression (whichever was last). The expressions were shown to naïve viewers in the same order that the participants encoded them, with rating pauses edited in between each expression, and the viewers watched one participant's whole set of expressions before moving on to the next. All videos were shown to the viewers without sound. Viewers used a multiple-choice response sheet that contained the following options: genuine worry, pretend worry, genuine sympathy, false sympathy, sarcasm, genuine happiness, and false happiness. Because we were only interested in expressions that were consensually seen as smiles by the viewers, we analyzed only the "genuine happiness" and "false happiness" judgments, and we omitted expressions for which fewer than three viewers chose one of these options. The perceived genuineness of the smiles was calculated as the proportion of these two judgments that were "genuine happiness" (proportion of genuine happiness judgments divided by sum of genuine and false happiness judgments).

Results

Duchenne Smiling in the Role-Play Task

Over the six role-plays in which participants were instructed to smile, 28 % of the smiles were Duchenne. The average percentage of Duchenne smiles was marginally higher for "genuine happiness" smiling role-plays ($M = 31$ %, $SD = 34$ %) than for "fake happiness" smiling role-plays ($M = 24$ %, $SD = 30$ %), $t(93) = 1.85$, $p = .07$. For the percentage of Duchenne smiling in each smiling role-play, see Table 1.

The naïve viewers' judgments of genuineness shed light on how natural and convincing the Duchenne smiles were perceived to be. Table 2 shows the correlations between perceived genuineness and the occurrence of Duchenne smiling (1 = Duchenne smile, 0 = non-Duchenne smile). Duchenne smiles were perceived as more genuine than non-Duchenne smiles (first column), but these effects were weakened when AU 12 intensity was taken into account (second and third columns), meaning that most of the genuineness impression was created by the intensity of the smile, not just the activation of AU 6.

Table 1 Percentages of smiling participants making Duchenne smiles for individual "fake happiness" and "genuine happiness" smiling role-plays

Role-plays	%	*SD*	*N*
"Fake happiness"			
Masked fatigue/irritation	14	35	73
Masked disappointment	38	49	94
Masked disliking	19	40	88
"Genuine happiness"			
Happy with friends	26	44	92
Happy greeting a friend	34	48	91
Happy over grade	37	48	93

Table 2 Correlations of perceived genuineness with Duchenne (vs. non-Duchenne) smiling and AU 12 intensity

Role-plays	Perceived genuineness with Duchenne smiling	Perceived genuineness with AU 12 intensity	Perceived genuineness with Duchenne smiling controlling for AU 12 intensity[a]
"Fake" happiness			
Masked fatigue/irritation	.16 (60)	.46* (60)	−.03
Masked disappointment	.05 (89)	.25* (89)	−.01
Masked disliking	.12 (77)	.27* (77)	.05
"Genuine" happiness			
Happy with friends	.29* (88)	.47*** (88)	.18^{+}
Happy greeting a friend	.16 (91)	.25* (91)	.09
Happy over grade	.42*** (92)	.49*** (92)	.28**

N is shown in parentheses. For the smile variables, 1 = smile was Duchenne, 0 = smile was not Duchenne

[a] Partial correlation

$^{+}$ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Duchenne Smiling in the Imitation Task

Seventy-one percent of the participants successfully imitated the photographed Duchenne smile, and 69 % of participants successfully imitated the non-Duchenne smile. When perceived genuineness was analyzed for the imitated Duchenne smile, as done above for the role-played smiles, the Duchenne smiles looked marginally more genuine than non-Duchenne smiles, $r(92) = .19$, $p = .07$. As before, smile intensity was correlated with perceived genuineness, $r(92) = .35$, $p < .01$, for the Duchenne photograph. When controlling for AU 12 intensity, there was no relationship between Duchenne smiling and increased perceptions of genuineness, $r_{partial} = .12$, $p = .25$.

Individual Differences: Correlations Between Tasks

One kind of evidence for individual differences consists of correlations among different tasks, as shown in Table 3. Production of deliberate Duchenne smiles in the "genuine happiness" smiling role-plays was related to production of deliberate Duchenne smiles in the "fake happiness" smiling role-plays. Furthermore, producing the Duchenne smile in both types of smiling role-plays was correlated with Duchenne smiling when imitating the non-Duchenne smile. Participants who successfully imitated the Duchenne photograph were more likely to make a Duchenne smile when imitating the non-Duchenne photograph, but there was no relationship between producing a Duchenne smile in either of the role-plays and successfully imitating the Duchenne smile.

Individual Differences: Correlations with Self-report Items

The post-experimental questions were examined in relation to Duchenne smiling in the smiling role-plays and in the imitation task. Participants who reported that they did well at putting on the expressions in the experimental tasks were more likely to correctly imitate the Duchenne smile, $r(94) = .24$, $p < .05$. Also, participants who reported that they were

Table 3 Correlations of deliberate Duchenne smiling between tasks

Variable	"Fake happiness" smiling role-plays	Imitating non-Duchenne	Imitating Duchenne
"Genuine happiness" smiling role-plays	.30**	.22*	.15
"Fake happiness" smiling role-plays		.24*	.13
Imitating non-Duchenne			.28**

For all variables, 1 = smile was Duchenne, 0 = smile was not Duchenne

* $p < .05$; ** $p < .01$

better at putting on false expressions in daily life were more likely to correctly imitate the Duchenne smile, $r(94) = .25$, $p < .05$, and to use Duchenne smiles when role-playing "genuine happiness," $r(93) = .22$, $p < .05$. Also, participants who rated themselves higher on this item produced more genuine-looking smiles when imitating the Duchenne photograph, $r(92) = .23$, $p < .05$ and marginally so even after smile intensity was controlled for, $r_{partial} = .18$, $p = .08$. Overall, these correlations support the notion that the deliberate Duchenne smile is an individual-difference ability and furthermore that people with this skill are aware of it.

Individual Differences: Gender

There was no evidence of gender differences in Duchenne smiling in the smiling role-plays (point-biserial correlations with gender were −.06 for the "fake happiness" smiling role-plays and .05 for the "genuine happiness" smiling role-plays). There was also no gender difference in participants' ability to imitate the Duchenne smile, $r(94) = .08$.

Discussion

Most writers on the Duchenne smile have talked of this smile as an involuntary, spontaneous expression of concurrent positive affect, using adjectives such as real, genuine, enjoyment, and felt (e.g., Bernstein et al. 2008; Ekman and Friesen 1982). We, like other recent investigators (Gosselin et al. 2010; Krumhuber and Manstead 2009), questioned this assumption and showed that a nontrivial number of participants could willfully produce a Duchenne smile when acting out role-plays that conveyed certain social messages, and a greater percentage deliberately produced a Duchenne smile when imitating a photographed Duchenne smile. This study also provided preliminary evidence that the ability to deliberately make the Duchenne smile is an individual difference.

These findings, along with previous findings of deliberate Duchenne smiling in other contexts (e.g., Krumhuber and Manstead 2009), strongly indicate that a genuine-looking expression of felt positive affect can be deliberately made when positive affect is not being felt. Our finding that deliberate Duchenne smiles are perceived as more genuine than non-Duchenne smiles indicates that when produced within a social context, deliberate Duchenne smiles show a perceptual difference from non-Duchenne smiles that mirrors differences seen in previous findings on perceptions of Duchenne smiles (e.g., Frank et al. 1993; Woodzicka 2008).

The current findings also strongly suggest that smile intensity is a confounding factor in the link between the Duchenne smile and increased ratings of genuineness. We are not the

first to find a correlation between smile intensity and Duchenne smiling (Ekman and Friesen 1982; Frank et al. 1993). However, many earlier studies of both Duchenne smile perception and Duchenne smile production were conducted before the coding rules for the Duchenne smile were revised to eliminate coding as Duchenne a smile that was merely the incidental result of a more intense AU 12 movement (Ekman et al. 2002). To find that intensity is correlated with the Duchenne smile even when incidental AU 6 movement is discounted means that more positive feeling (whether felt or feigned) is reflected in both AU 12 and AU 6, without one being the artifact of the other. Because of this correlation, intensity remains an important possible confounding factor that researchers should be aware of when designing both perception and production studies involving Duchenne smiling.

The increase in rate of Duchenne smiling from the role-plays to the smile imitation task shows that participants exercised discretion in their use of the expression. The larger percentage of Duchenne smiles in the imitation task allows us to infer that participants had more willful control over use of these muscles than they used in the role-plays. This is not surprising considering that performing the role-plays required participants to think about the assigned scenario, imagine how they would act under such circumstances, remember and say the assigned sentence to the video camera, and decide if they wanted to perform a convincing (Duchenne) smile while doing so. This is a much more cognitively complex activity than required in imitating a photograph. Furthermore, one can presume that a condition of producing the Duchenne smile in the role-plays would be implicit or explicit knowledge about the pragmatics of the Duchenne smile—when one would use it and what its likely impact would be. Although previous research has found that many perceivers can distinguish Duchenne from non-Duchenne smiles, attribute more favorable qualities to Duchenne smiles, and explicitly state which muscles are involved in Duchenne smiles, not all perceivers possess such knowledge and even if they do, they might not be motivated to produce a Duchenne smile in the role-play scenarios. It is likely that in our role-plays, some participants who did not produce a Duchenne smile had the capacity to do so (as indicated by the success rate when imitating the photograph), and might have produced a Duchenne smile if they realized it was relevant in the role-plays and were motivated to do so. Therefore, participants' capacity to make the Duchenne smile may not have been fully manifested in the role-plays, though it was still present. It is also possible that because nothing was actually at stake in the role-plays, our results may underestimate the rate of deliberate Duchenne smiles in real life, where the motivation to produce them might be much greater than experienced by the students in our laboratory.

"Genuine happiness" role-plays were marginally more likely to contain deliberate Duchenne smiles than "fake happiness" role-plays. If, in real life, people find it easier to produce a deliberate Duchenne smile when it is not masking a discrepant state, perhaps that is because the latter produces psychological conflict or dissonance. In our study, participants may have felt more ambivalence, awkwardness, and possibly even guilt about producing deliberate Duchenne smiles in the "fake happiness" smiling role-plays, and these psychological states might, in turn, have interfered with successful performance of the smile. Therefore, it is possible that participants used discretion in their decision to produce the smile, and decided to use it when pretending to show genuine emotion and not when pretending to cover up negative affect which could likely mirror the choices they make in their everyday lives.

Regarding individual differences, we found correlations between tasks indicating that deliberate Duchenne smiling has some degree of trait consistency. Duchenne smiling was positively correlated between the "fake happiness" and "genuine happiness" smiling

role-plays, and participants who were more likely to put on the deliberate Duchenne smile in the smiling role-plays were also more likely to put on the expression when imitating the non-Duchenne smile. The lack of relationship between smiling behavior in the role-plays and while imitating the Duchenne smile is likely the result of a greater number of participants having the ability to put on the Duchenne smile than the knowledge of when to use it in a social situation. There was a group of participants who demonstrated an ability to deliberately Duchenne smile when imitating the photograph who did not Duchenne smile in the majority of the role-plays indicating either that they did not know that a Duchenne smile was called for in the role-plays or chose not to display a Duchenne smile in a social simulation where they were not feeling genuinely happy.

This study further showed that people with the ability to produce a deliberate Duchenne smile reported being better able to put on false expressions in their daily lives and reported that they had done a better job putting on the expressions in the experimental tasks. This indicates that people have some introspective knowledge of their own smiling behavior and ability and likely value the ability as a social skill.

Findings from the present study strengthen the argument that people can volitionally activate their cheek raiser muscle and put on a Duchenne smile. Future research will further investigate individual differences, and will use behavioral outcomes to measure similarities in people who deliberately produce the Duchenne smile.

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Appendix

See Table 4.

Table 4 Smiling role-play descriptions

	Wording
Role-play	
Masked fatigue/ irritation	You need to portray false happiness: You have a retail job where you have to greet customers all day. You are actually feeling worn out and irritated, but you put on your best smile and say, "Can I help you find anything?"
Masked disappointment	You put on a "cover-up" happy face: Your mom gives you a present you don't like but you DON'T want her to know you are disappointed. You smile and say, "Hey, this is really nice!"
Masked disliking	You act friendly even though you don't mean it: You run into someone you don't like but you want to cover it up. You smile and say, "Hi, it sure is nice to see you!"
Happy with friends	You are feeling happy: You are together with your best group of friends. One of them suggests going out to a great new club and you smile and say, "That's a great idea!"
Happy greeting friend	You are feeling happy: You meet a good friend who has been out of the country. Your face has a happy smile and you say, "Hey, I haven't seen you in so long!"
Happy over grade	You are feeling happy: Your professor just told you that you scored the best in the class on a hard exam. You smile and say to him, "Wow! That's great!"

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