Can Duchenne Smiles Be Feigned?  
New Evidence on Felt and False Smiles

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We investigated the value of the Duchenne (D) smile as a spontaneous sign of felt enjoyment. Participants either smiled spontaneously in response to amusing material (spontaneous condition) or were instructed to pose a smile (deliberate condition). Similar amounts of D and non-Duchenne (ND) smiles were observed in these 2 conditions (Experiment 1). When subsets of these smiles were presented to other participants, they generally rated spontaneous and deliberate D and ND smiles differently. Moreover, they distinguished between D smiles of varying intensity within the spontaneous condition (Experiment 2). Such a differentiation was also made when seeing the upper or lower face only (Experiment 3), but was impaired for static compared with dynamic displays (Experiment 4). The predictive value of the D smile in these judgment studies was limited compared with other features such as asymmetry, apex duration, and nonpositive facial actions, and was only significant for ratings of the upper face and static displays. These findings raise doubts about the reliability and validity of the D smile and question the usefulness of facial descriptions in identifying true feelings of enjoyment.

Keywords: emotion, facial expression, Duchenne smile, smile perception

According to discrete emotion theory, facial expressions show emotions and are intrinsically linked to feelings (Ekman, 1982, 1992a). In this research tradition, the Duchenne (D) smile has been proposed as a spontaneous and genuine expression of positive emotions such as happiness, pleasure, or enjoyment (Ekman, 1992b; Ekman, Davidson, & Friesen, 1990; Frank & Ekman, 1993). This type of smile is named after the French neuroanatomist Duchenne de Boulogne who described the smile and suggested that it is “put into play by the sweet emotions of the soul...” (Duchenne, 1862/1990, p. 72). In the Facial Action Coding System (FACS; Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002), a system for coding visible facial movements, the appearance of the D smile has been classified as a combination of two facial muscle movements: the zygomaticus major muscle (Action Unit [AU] 12 in FACS), which pulls the lip corners up, thereby producing a smiling mouth, and the orbicularis oculi muscle (AU 6) involved in D smiles has consequently been labeled a reliable muscle (Ekman et al., 1980; Levenson, Ekman, & Friesen, 1990). The orbicularis oculi muscle (AU 6) involved in D smiles has consequently been labeled a reliable muscle (Ekman, 1997, p. 390). Because this muscle is difficult to control, it is not available for use in false expressions (Ekman, 1985, 1989); therefore, it provides a reliable and spontaneous sign of enjoyment. The present research focused on this voluntary aspect and investigated how reliable and valid the D smile actually is with respect to its expression and perception.

The Expression of Duchenne Smiles

There is evidence that D smiles occur when positive emotions are elicited and when people enjoy themselves. Specifically, D smiles are shown more often (than ND smiles) in response to pleasant stimuli (Ekman et al., 1990; Soussignan & Schaal, 1996) and when positive feelings such as amusement and enjoyment are reported (Ekman, Friesen, & O’Sullivan, 1988; Frank et al., 1993). D smiles are also associated with self-reports of love and good
mood (Gonzaga, Keltner, Londahl, & Smith, 2001; Scherer & Ceschi, 2000), marital satisfaction (Harker & Keltner, 2001), and health improvement in clinical populations (Ekman, Matsumoto, & Friesen, 1997; Steiner, 1986). In children, more D smiles (than ND smiles) occur in response to a familiar adult (Fox & Davidson, 1988), when children are gazing at their smiling mother (Messinger, Fogel, & Dickson, 1999, 2001), and during success in an achievement game (Schneider & Unzer, 1992).

These studies show that D smiles tend to be shown under circumstances of spontaneously experienced positive affect. However, there is also evidence that D smiles occur in posed and negative contexts. Specifically, D smiles have been observed both when participants smiled spontaneously and when they were instructed to do so (Schmidt, Ambadar, Cohn, & Reed, 2006). For such posed smiles, the majority of the participants have been found to show orbicularis oculi—AU 6—activation (Schmidt, Bhattacharya, & Denlinger, 2009; Smith, Smith, & Ellgring, 1996); in one study of 105 posed smiles, 67% were found to be D smiles (Schmidt & Cohn, 2001). D smiles have also been found to occur in response to negative film clips (Ekman et al., 1990), when negative emotions are being concealed (Ekman et al., 1988), after failure in a game (Schneider & Josephs, 1991; Zaalberg, Manstead, & Fischer, 2002), during tickling in the absence of positive affect (Harris & Alvarado, 2005), in expressions of embarrassment (Keltner, 1995), and when talking about negative events (Lee & Beattie, 1998). Bonnano and colleagues observed D laughter and smiles when participants talked about a recently deceased spouse (Keltner & Bonanno, 1997) and in response to a negative affect manipulation during a monologue task (Papa & Bonanno, 2008). It is interesting that these D expressions and only these D expressions were related to a reduction or dissociation of negative affect and to better social relations at a later time. Ansfield (2007) suggested that smiles serve a self-regulatory function of coping with negative emotional experiences. In his study, the more participants smiled while viewing distressing videos, the more positive affect they reported afterward. The D expression, whether made spontaneously or deliberately, may therefore foster positive self-regulation and lead to relevant physiological and affective changes through facial feedback mechanisms.

Supportive evidence comes from Soussignan (2002), who showed that through the unconscious facilitation of D smiles by having participants hold a pen between their teeth, self-reports of positive experience, skin conductance, and heart rate in response to pleasant film clips all increased. These associations were not found for ND smiles of similar intensity. However, the conscious voluntary production of D smiles by muscle-by-muscle instruction has also been shown to generate relevant physiological changes (Ekman & Davidson, 1993). When contracting the zygomaticus major and the orbicularis oculi, pars lateralis muscles on command, patterns of regional brain activity were similar to those of spontaneous displays of D smiles. Moreover, 32 of 45 undergraduates (71.1%) could produce such deliberate D smiles.

Such findings suggest that D smiles exert a positive focus on subjective and physiological variables that resemble those occurring during spontaneous positive affect. However, and in contrast to what has been previously claimed, D smiles do not only occur as a sign of genuine felt enjoyment. People can and do display D smiles under deliberate circumstances and in the absence of positive feelings. The suggestion that 80% of the population would be unable to voluntarily contract the orbicularis oculi, pars lateralis muscle and thus be capable of producing a false D smile (Ekman et al., 1990; Frank & Ekman, 1993) should therefore be treated with caution. Indeed, the evidence generally cited in support of this suggestion comes from observations and research with young children in whom AU 6 was not measured at all (Ekman et al., 1980) or from studies showing that happy D smiles were rated actually as the easiest configuration to produce deliberately by trained actors, college students, and local people (Levenson et al., 1990).

The Perception of Duchenne Smiles

There are several studies showing that D and ND smiles are perceived differently. Individuals displaying D smiles are evaluated as more emotional and interpersonally positive (Frank et al., 1993; Harker & Keltner, 2001; Messinger, Cassel, Acosta, Ambadar, & Cohn, 2008), as being in better humor (Scherer & Ceschi, 2000), and as expressing more pleasantness (Soussignan & Schaal, 1996) than their ND smiling counterparts. D smiles also elicit more positive emotional and affiliative responses in other people (Gonzaga et al., 2001; Keltner & Bonanno, 1997; Surakka & Hietanen, 1998), contribute to perceptions of greater spontaneity and authenticity (Gosselin, Beaupré, & Boissoinneault, 2002; Gosselin, Perron, Legault, & Campanella, 2002; Giudice & Colle, 2007; Hess & Kleck, 1994), and lead to more positive evaluations of peripheral, unrelated attributes (Peace, Miles, & Johnston, 2006).

It is interesting that contraction of the orbicularis oculi muscle occurs in negative emotions, not only in positive ones. Ekman and Friesen (1982) noted that the outer part of the orbicularis oculi muscle is also involved when distress, pain, or sadness are felt. Messinger and colleagues (Bolzani Dinehart et al., 2005; Messinger, 2002) showed that eye constriction (AU 6) had significant effects on raters’ perceptions of the intensity of positive emotions as well as negative ones. In particular, when eye constriction accompanied infants’ smiles, it made positive expressions appear more positive; when it accompanied cry faces, it made these expressions appear more negative. The same facial movement was therefore seen as signaling increased intensity in two qualitatively different emotions. A further complexity is that the D smile can also occur in conjunction with facial features (i.e., frowning, dimpling, lip tightening, lip corner depressing) indicative of negative emotions (Ekman, 1985). Such modulations of smiling have been found in spontaneous as well as in deliberate or social smiles (Schmidt, Cohn, & Tian, 2003; Schmidt et al., 2009) and have been shown to influence observers’ ratings of the happiness and amusement of the sender (Ambadar, Cohn, & Reed, 2009; Gosselin, Beaupré, & Boissoinneault, 2002; Hess, Kappas, McHugo, Kleck, & Lanzetta, 1989). Therefore, neither the D smile nor its distinctive feature, AU 6, is uniquely associated with the perception of positive emotion; both can co-occur with nonpositive facial actions.

Furthermore, factors other than the D marker have been proposed as differentiating between spontaneous and happy and posed smiles (see Frank & Ekman, 1993; Frank et al., 1993). One such factor is the greater symmetry of spontaneous smiles. Several studies found that smiles made spontaneously in reaction to an experimenter’s joke or a pleasant film were more symmetrical than

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were deliberate smiles made on request (Ekman, Hager, & Friesen, 1981; Hager & Ekman, 1997; Skinner & Mullen, 1991). Schmidt et al. (2006, 2009), however, did not find the proposed difference in symmetry, and other studies have failed to show an effect of symmetry on perceivers’ ratings of happiness and amusement (Ambadar et al., 2009; Gosselin, Perron, et al., 2002).

It has also been argued that spontaneous smiles are smoother than their deliberate counterparts. Spontaneous smiles have been found to be smoother and to contain fewer irregularities (pauses and stepped intensity changes) than deliberate smiles (Hess & Kleck, 1990; Weiss, Blum, & Gleberman, 1987). Smoothness versus irregularity also has been shown to influence observers’ judgments of the degree of control of the expression (Hess & Kleck, 1994). Furthermore, temporal parameters such as the relative durations of onset, apex, and offset phases of a smile have been proposed to distinguish between spontaneous and deliberate smiles. Some studies have found longer onset and offset times for spontaneous smiles than for deliberate ones (Hess & Kleck, 1990; Schmidt et al., 2006, 2009). Effects of onset, apex, and offset durations have been demonstrated for ratings of smile genuineness (Krumhuber & Kappas, 2005; Krumhuber, Manstead, Cosker, Marshall, & Rosin, 2009; Krumhuber, Manstead, & Kappas, 2007; Krumhuber, Manstead, Cosker, et al., 2007), but not for accuracy of expression discrimination or judgments of control when only onset speed was considered (Hess & Kleck, 1994).

Of all the attributes of felt, genuine smiles, the D marker has been proposed as the most reliable, robust, and diagnostic marker. As Frank and Ekman (1993) stated, “All the other markers (i.e., symmetry, smoothness, duration) should be considered necessary, but not necessarily sufficient indicators of an enjoyment smile” (p. 21). It is interesting that the signal value of the D smile rarely has been studied alongside these other physical markers. In some cases, only one feature (i.e., overall duration or symmetry or nonpositive facial actions) was measured or manipulated in the presence of the D smile, yielding evidence of the dominant role of the D marker (Frank et al., 1993; Gosselin, Beaupré, & Boissonneault, 2002; Gosselin, Perron, et al., 2002). Hess and Kleck (1994) explored a combination of cues, but their results pertained more globally to spontaneous expressions, combining positive and negative emotions. In a recent study by Ambadar et al. (2009), the signal value of the D marker was tested in the context of other smile characteristics such as asymmetry of amplitude, onset and offset velocity, and nonpositive facial actions (called smile controls). Although AU 6 occurred more often during smiles perceived to reflect amusement than during polite or embarrassed smiles, the presence of the D marker on its own was not sufficient to signify amusement. How much the D smile, as opposed to other physical markers, affects perceptions of positive emotion therefore remains unclear.

Present Research

The objective of the present research was to investigate the reliability and validity of the D smile. As we have seen, there is a widespread assumption that D smiles are spontaneous expressions that reflect felt positive emotion. We aimed to test this assumption systematically by investigating both spontaneous and deliberate D and ND smiles. In a first experiment, we focused on the expression of these different types of smile. Here, we studied whether and how often people activated the orbicularis oculi, pars lateralis muscle (AU 6) when smiling voluntarily. We also examined whether D smiles occurred solely or predominantly under spontaneous conditions, and whether ND smiles occurred solely or predominantly under deliberate conditions. If the presence of AU 6 in D smiles is a reliable sign of spontaneous enjoyment, it should not occur in false or voluntary smiles. Moreover, senders should report subjective experience of positive emotion when exhibiting D smiles, but not when exhibiting ND smiles.

In subsequent studies, we examined how D and ND smiles were perceived, and whether people made different judgments of these two smile types when they were made under spontaneous and deliberate conditions. To date, no study has explored the perception of both spontaneous and deliberate D smiles. In a series of experiments, we investigated perceivers’ ratings of these smiles with respect to spontaneity, genuineness, and amusement. We also examined whether judges differentiated between more and less intense D smiles made in the spontaneous condition (Experiment 2), and whether ratings of smiles were affected by having access to the upper versus the lower face (Experiment 3) or when seeing static versus dynamic displays (Experiment 4). As well as this focus on how smile types affected judgments, we tested the predictive value of the D marker alongside other behavioral features, namely asymmetry; irregularity; onset, apex, and offset durations; and nonpositive facial actions. If the D marker is the most diagnostic feature of an enjoyment smile, it should play a major role in predicting how genuine and amused the smile is judged to be. We therefore expected its utility in predicting the ratings of smiles in Experiments 2–4 to be consistent and at least as great as (if not greater than) the predictive value of the other physical attributes.

**Experiment 1**

The purpose of this study was to test the notion that D smiles signal spontaneous felt emotions, with AU 6 being a reliable indicator of enjoyment (Ekman, 1993; Ekman & Friesen, 1982). To this end, we compared the amount of D and ND smiles exhibited under spontaneous and deliberate conditions and examined the levels of positive emotions that were reported by individuals showing these smile expressions.

**Method**

**Participants**

Thirty-two undergraduate students (16 men, 16 women), ages 18 to 35 years ($M = 22.59$ years, $SD = 4.01$) at Cardiff University participated on a voluntary basis and were paid £3.

**Materials and Procedure**

In the spontaneous condition, participants saw six amusing stimuli intended to induce positive emotional feelings. The stimuli consisted of two jokes, one cartoon, and three film clips, each of which was approximately 15 s in length. They were selected from a larger pool of 34 stimuli that had been pretested on 19 participants (9 women, 10 men, ages 20–26 years, $M = 22.65$ years, $SD = 2.06$) for their capacity to evoke amusement ($M = 5.37$),
pleasure ($M = 4.54$), and happiness ($M = 4.45$) on a 7-point rating scale ($1 = \text{not at all}, 7 = \text{extremely}$). Apart from one joke that had been used in a previous study, all stimuli were chosen from the Internet (e.g., http://www.allfunnypictures.com). The amusing stimuli were separated by filler items, that is, pictures of inanimate objects drawn from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2001) that had low arousal and neutral valence scores ($M = 2.49$ and $M = 4.89$, respectively, on a 9-point scale). These filler stimuli were presented for 8 s each and were intended to return participants to a neutral emotional state.

In the deliberate condition, participants saw a different set of six IAPS slides of inanimate objects that had low arousal ($M = 2.47$) and neutral valence scores ($M = 5.01$) and were intended to serve as neutral stimuli. Each neutral stimulus was presented for 10 s. Following Hess and Kleck (1990), participants were instructed to pose in front of the video monitor an expression that made it look as if they were watching something funny and in a way that would be as convincing as possible. More specifically, they were asked to smile as they would if they felt amused. They were not allowed to talk and had to rely simply on positive facial expressions. To motivate participants, an incentive of £10 was promised if their smile expressions proved to be the most convincing of those made by all participants (see Ekman et al., 1988; Schmidt et al., 2003, for a similar procedure). The experimenter was not present during either condition.

Participants always completed the spontaneous procedure first. The rationale for this is the same as the one offered by Ekman et al. (1988, 1990), namely that the reverse order would be likely to result in interference effects between the two conditions. Within each condition, the stimuli were presented in one of two different sequences using MediaLab (Empirisoft) software. Participants were asked to consent to being video recorded at the start of the session, and their facial behavior was recorded during the whole procedure. We also asked for participants’ permission to use the video recordings of their behavior in future research projects. Apart from three people who objected to the future use of their recordings, all participants agreed to both requests.

**Dependent Variables**

_Facial action units._ For each participant, the first smile that occurred in each of the six spontaneous and six deliberate epochs was selected for analysis to ensure a balanced representation of smiles (for a similar approach, see Cohn & Schmidt, 2004; Schmidt et al., 2003, 2006). This resulted in a set of 384 smiling episodes. Facial activity during these episodes was scored using the FACS (Ekman & Friesen, 1978; Ekman et al., 2002). FACS enables the measurement of all visible facial behavior and describes it in terms of 44 action units. For the purposes of the present research, two of these action units, AU 12 and AU 6, were treated as the primary dependent variables (for a similar procedure, see Papa & Bonanno, 2008; Schmidt et al., 2006). AU 12 refers to activity of the zygomaticus muscle and involves a lip corner pull (smiling mouth). AU 6 refers to activity of the orbicularis oculi, pars lateralis muscle that raises the cheeks, gathers the skin around the eye, and produces crow’s feet wrinkles. Smile episodes that included both AU 12 and AU 6 were defined as D smiles, whereas episodes that included only AU 12 were defined as ND smiles (cf. Frank et al., 1993).

For all samples in the spontaneous and deliberate epochs, we scored both the frequency of AU 12 and AU 6 and the maximum intensity ($1 = \text{trace} \to 5 = \text{maximum}$) that AU 12 reached during each episode. Two FACS-trained coders who were blind to the different stimulus sequences within condition individually coded all the facial activity shown by the 32 participants. In addition, a FACS-certified coder scored 50% of the samples (i.e., 192 smiling episodes). Intercoder reliability was assessed as mean percentage agreement (%) and chance-corrected Cohen’s kappa ($\kappa$). Intensity differences of 1 point were treated as agreements (for a similar approach, see Messinger et al., 2008). Mean agreement was 98.44% ($\kappa = 0.94$) for AU 12, 89.06% ($\kappa = 0.79$) for AU 6, and 96.35% ($\kappa = 0.95$) for AU 12 intensity, demonstrating high reliability.

_Subjective emotion._ Immediately following each stimulus presentation, participants were asked to report the intensity with which they had felt each of the following emotions while viewing the stimulus just seen: amusement, pleasure, happiness, surprise, and interest. Ratings were made on 7-point scales, with response options ranging from 1 (not at all) to 7 (extremely). These questions were posed in a randomly selected order that varied with each participant.

**Results and Discussion**

Preliminary analyses showed that neither stimulus type (jokes, cartoon, film clips, pictures) nor the sequence in which the stimuli were presented had an effect on any of the dependent variables ($p > .05$). These factors were dropped from further analyses. For each participant, frequency or average scores (intensity, emotion) for D and ND smiles were computed in the spontaneous and deliberate conditions. These four scores were entered into mixed analyses of variance (ANOVAs) with two within-subjects factors, condition (spontaneous, deliberate) and smile type (D, ND), and one between-subjects factor, sex of participant. Separate analyses were carried out on the measures of facial activity (frequency, intensity) and the measures of participants’ subjective emotion.

_Facial Activity._

ANOVA revealed a significant main effect of smile type on frequency of smiling, $F(1, 30) = 33.92$, $p < .001$, $\eta^2_p = .53$. Overall, participants displayed more D (76.5%) than ND smiles (23.3%). The condition main effect was not significant, $F(1, 30) = 2.14$, $p > .05$, $\eta^2_p = .07$, nor was the interaction between condition and smile type, $F(1, 30) = 3.81$, $p > .05$, $\eta^2_p = .11$. Overall, 70% of smiles in the spontaneous condition were D smiles, and the remaining 30% were ND smiles. By comparison, 83% of smiles in the deliberate condition were D smiles, and the remaining 17% were ND smiles. Thus, D and ND smiles appeared in approximately equal proportions in the spontaneous and deliberate conditions. This finding is consistent with evidence (Schmidt & Cohn, 2001; Schmidt et al., 2006, 2009; Smith et al., 1996) that

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1 Arousal scores for the six amusing stimuli used in the spontaneous condition were below the midpoint ($M = 2.82$, $SD = 0.84$, 7-point scale) and similar to those of the stimuli used in the deliberate condition, as indicated by an independent sample of 10 participants (5 men, 5 women), ages 25 to 32 years ($M = 28.9$ years, $SD = 2.42$).
people are able to pose a D smile deliberately, and that they do so quite frequently. Thus, there is no direct evidence that AU 6 in D smiles reflected spontaneity, whereas its absence in ND smiles reflected deliberateness (Parkinson, 2005). The sex of participant main effect was not significant, $F(1, 30) = 0.43, p > .05$, $\eta^2_p = .01$.

With respect to smile intensity, D smiles had higher intensity levels ($M = 3.11$) than ND smiles ($M = 0.97$), $F(1, 30) = 106.67, p < .001$, $\eta^2_p = .78$, an effect observed by Ekman and Friesen (1978) and also found in a recent study by Messinger et al. (2008). The main effects of condition, $F(1, 30) = 0.01, p > .05$, $\eta^2_p = .00$, and sex of participant, $F(1, 30) = 1.37, p > .05$, $\eta^2_p = .04$, were not significant. However, there was a significant interaction between condition and smile type, $F(1, 30) = 8.52, p < .01$, $\eta^2_p = .22$. Analysis of simple effects (see Winer, Brown, & Michels, 1991) showed that when participants were instructed to pose smiles, D smiles were more intense ($M = 3.37$) than were D smiles observed in the spontaneous condition ($M = 2.85$), $F(1, 30) = 5.67, p < .05$, $\eta^2_p = .16$. Thus, participants were able to simulate the D smile by putting on a strong smile that also activated the upper facial muscles. The corresponding difference for ND smiles was not significant (spontaneous: $M = 1.24$, deliberate: $M = 0.71$), $F(1, 30) = 3.75, p > .05$, $\eta^2_p = .11$.

Subjective Emotion

A factor analysis (principal components with varimax rotation) of responses to the five emotion items showed that amusement, pleasure, happiness, surprise, and interest all loaded on the same factor (explaining 81.83% of the variance). They were therefore combined to form a positive emotionality scale (Cronbach’s alpha = .94). ANOVA showed significant main effects of condition, $F(1, 30) = 53.78, p < .001$, $\eta^2_p = .64$, and smile type, $F(1, 30) = 21.67, p < .001$, $\eta^2_p = .42$. Smiles shown in the spontaneous condition were accompanied by significantly more positive emotion ($M = 3.03$) than were those shown in the deliberate condition ($M = 1.25$), confirming that the elicitation procedures gave rise to substantially different levels of positive affect. Participants also reported having experienced significantly more positive emotion during epochs in which they displayed D smiles ($M = 2.84$) than in epochs in which they displayed ND smiles ($M = 1.43$). Thus, smile type was also related to positive emotion. Consistent with the notion that the D smile reflects true felt enjoyment (Ekman et al., 1988, 1990; Frank et al., 1993), spontaneous D smiles were accompanied by more positive emotion ($M = 3.74$) than were deliberate D smiles ($M = 1.94$), $F(1, 30) = 29.55, p < .001$, $\eta^2_p = .50$. Similarly, spontaneous ND smiles were associated with more positive emotion ($M = 2.31$) than were deliberate ND smiles ($M = 0.55$), $F(1, 30) = 22.89, p < .001$, $\eta^2_p = .43$. The interaction between condition and smile type was not significant, $F(1, 30) = 0.01, p > .05$, $\eta^2_p = .00$, nor was the main effect of sex of participant, $F(1, 30) = 3.79, p > .05$, $\eta^2_p = .11$. Additional correlation analyses showed a significant positive relationship between degree of positive emotion and smile intensity, $r(32) = .54, p < .01$.

Summarizing, neither D smiles nor ND smiles occurred solely or predominantly under spontaneous or deliberate conditions. Rather, whether or not a D smile was shown was associated with the intensity of the expression and with the amount of positive emotion experienced. In a series of judgment studies reported below, we focused on the perception of smile expressions. Specifically, we investigated how D and ND smiles made under spontaneous and deliberate conditions were perceived by naive observers. Furthermore, we examined the extent to which the D marker, along with other attributes (e.g., asymmetry; irregularity; onset, apex, and offset durations; and nonpositive facial actions) predicted the ratings made by observers.

**Experiment 2**

Our aim in this study was to examine whether observers would distinguish in their judgments between D and ND smiles that were made under spontaneous and deliberate conditions. For example, would D smiles originating from a spontaneous condition be rated differently from those arising from a deliberate condition? If there is only type of enjoyment smile, spontaneous D smiles should be seen as more genuine than deliberate D smiles or spontaneous ND smiles. An additional goal was to study the effects of expression intensity on judgments of D smiles. Much research has shown that the intensity of an expression significantly influences ratings of positive emotion (Bolzani Dinehart et al., 2005; Hess, Blairy, & Kleck, 1997; Messinger, 2002; Messinger et al., 2008). We therefore wanted to test whether judges would distinguish between spontaneous D smiles that differed in intensity. If the expression intensity of the sender plays a role in the evaluation of D smiles, more intense D smiles should be seen as reflecting greater subjective enjoyment than less intense D smiles.

**Method**

**Participants**

Fifty-two undergraduate students (22 men, 30 women), ages 18–33 years ($M = 20.17$ years, $SD = 2.25$) at Cardiff University took part in this study and were given either course credit or payment of £2.

**Stimulus Material and Design**

It has been argued that the “true” spontaneous D smile should be discernible mainly at a low or moderate intensity level, when the smiling action of the mouth does not automatically lead to a contraction of the upper face muscles, thereby giving the overall appearance of a D smile (Ekman, 1985; Frank & Ekman, 1993). The D and ND smiles selected from Experiment 1 were therefore not of extreme intensity in FACS terms, but rather of slight or moderate/pronounced intensity. We chose smiles that began and ended with a neutral baseline expression and for which senders reported having felt moderate or high emotions (i.e., pleasure, amusement, and happiness ratings of 3 or higher on a 7-point scale where 1 = not at all and 7 = extremely) in the spontaneous condition and low or no emotions (i.e., pleasure, amusement and happiness ratings of 2 and lower) in the deliberate condition (for a similar procedure, see Hess & Kleck, 1994). From the pool of smile expressions generated in Experiment 1, there were 30 smiles of each type that met these criteria: (a) 6 spontaneous D smiles (pronounced): $M_{\text{Intensity}} = 3.7, M_{\text{positive emotion}} = 5.2$; (b) 6 spontaneous D smiles (moderate): $M_{\text{Intensity}} = 3.0, M_{\text{positive emotion}} = 3.8$; (c) 6 spontaneous ND smiles: $M_{\text{Intensity}} = 2.2, M_{\text{positive emo-}}$
tion = 3.9; (d) 6 deliberate D smiles: $M_{intensity} = 3.5, M_{positive\ emotion} = 1.6$; and (e) 6 deliberate ND smiles: $M_{intensity} = 2.0, M_{positive\ emotion} = 1.7$.

Overall, the intensity of spontaneous D smiles was similar to that of deliberate D smiles ($M = 3.4$ vs. $M = 3.5$). The same was the case for ND smiles, which did not differ with respect to intensity between the spontaneous and deliberate conditions ($M = 2.2$ vs. $M = 2.0$). In this way, we sought to eliminate expression intensity as a possible explanation for differential responses to smiles in the spontaneous and deliberate conditions (for a similar approach, see Miles & Johnston, 2007; Peace et al., 2006; Soussignan, 2002) and rather study the effects of expression intensity in the perception of spontaneous D smiles (pronounced vs. moderate).?

In addition to the D marker, all 30 smiles were scored by two FACS-certified coders who were blind to condition (i.e., spontaneous vs. deliberate) for the following behavioral features: Asymmetry (mean agreement = 93.34%; $\kappa = 0.86$) was coded if the smiling action was stronger on one side of the face (Ekman et al., 1981). This was the case for deliberate ND smiles, which were more asymmetric (83.3%) than both spontaneous D smiles (pronounced) and spontaneous ND smiles (0.0% and 16.7%, $p < .01$ and $p < .05$), $F(4, 20) = 3.49, p < .05, \eta_p^2 = .41$.

Irregularity (mean agreement = 90%, $\kappa = 0.75$) was coded if the smile expression faded and reinfused or was characterized by discontinuities in the onset, apex, or offset phases (Hess & Kleck, 1990). No significant differences in irregularity occurred between the five smile types, $F(4, 20) = 0.54, p > .05, \eta_p^2 = .10$.

Nonpositive facial actions (mean agreement = 93.34%, $\kappa = 0.86$) were coded if frowning (AU 4), lip pressing (AU 24), dimpling (AU 14), lip corner depressing (AU 15), lid tightening (AU 7), or lower lip depressing (AU 16) occurred during the smile. Such smile controls or dampening movements (Ambadar et al., 2009; Schmidt et al., 2009) previously have been associated with nonjoyful feelings (Ekman, 1985; Ekman et al., 2002). There were no significant differences in the presence of nonpositive facial actions between the five smile types, $F(4, 20) = 0.73, p > .05, \eta_p^2 = .13$.

Onset time, apex time, and offset time were coded by a FACS-trained coder and a FACS-certified coder within a 0.5-s tolerance window (see Sayette, Cohn, Wertz, Perrott, & Parrott, 2001) and yielded high correlations between the two coders (intraclass $r = .79$).

Onset duration was measured as the number of frames from the start of the smile expression to its zenith. Apex duration was the number of frames the smile expression was held at its peak, and offset duration was measured as the number of frames from first evidence of decay of the smile expression until it stopped decaying (Ekman et al., 2002; Hess & Kleck, 1990). There were no significant differences between the five smile types in onset duration, $F(4, 20) = 1.83, p > .05, \eta_p^2 = .27$, or offset duration, $F(4, 20) = 1.02, p > .05, \eta_p^2 = .17$. Onset durations were on average 25.65 frames (1.03 s), whereas offset durations were on average 49.80 frames (1.99 s). However, spontaneous ND smiles were shorter in their apex durations ($M = 12$ frames, 0.48 s) than the other smile types ($M = 90.79$ frames, 3.63 s), $F(4, 20) = 12.04, p < .001, \eta_p^2 = .71$.

Correlation analyses of all smile features showed a significant relationship only between temporal features of smiles. The longer the onset, the longer the smile was held at its apex ($r = .37, p < .05$); the longer the apex duration, the longer the offset ($r = .42, p < .05$).

Roughly the same number of smiles came from male and female encoders (14:16). A given encoder could be shown more than once with a different smile expression. On average, there were two smile expressions per encoder that could be any of the types described above. In this way, we tried to avoid presenting judges with a standard baseline that they could rely on to rate the genuineness of an expression. The 30 smile expressions featuring five different types of smiles were displayed as movie clips (750 × 576 pixels, 25 frames/s) in MediaLab (Empirisoft) and shown in random order.

Procedure

After signing a consent form, participants were told that they would see short video clips of several people. They were informed that each person had been shown some amusing stimuli (e.g., funny pictures, movies, and texts) that were intended to elicit positive emotional feelings and some neutral stimuli (i.e., pictures of inanimate objects) that were intended to elicit no specific emotion. They were further told that the amusing stimuli resulted in smiles that were spontaneous and accompanied by genuine amusement of the person, and that when presented with neutral stimuli, the person viewing them had been asked to pose a smile as if s/he was amused. We instructed participants to look carefully at each smile and then to make judgments about it, including whether it was spontaneous or posed. The video sequences were initiated by using the mouse to click a Start button on the computer screen.

Dependent Variables

After each sequence, participants were asked to answer the following questions on 7-point scales: (a) To what extent is the smile you have just seen spontaneous or posed? (1 = deliberate, 7 = spontaneous), (b) to what extent is the smile you have just seen genuine or fake? (1 = fake, 7 = genuine), and (c) to what extent was the person you have just seen amused at the time of the smile? (1 = not at all, 7 = very).

Results and Discussion

Analysis of Variance

A multivariate analysis of variance (MANOVA) with sex of encoder and smile (five levels: pronounced spontaneous D, deliberate spontaneous D, spontaneous ND, deliberate D, deliberate ND) as within-subjects factors and sex of participant as a between-subjects factor was conducted on the three dependent variables (spontaneity, genuineness, and amused). There were no significant effects associated with sex of encoder, $F(3, 48) = 0.28, p > .05, \eta_p^2 = .02$, and this factor was dropped in further analyses. For all

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2 Examples of the different types of smiles can be obtained from Eva G. Krumhuber on request.

3 Ratings of how spontaneous and genuine the smile appeared to be were consistent and highly correlated with each other ($rs > .86, ps < .001$), and analyses were virtually the same across all three experiments. Because smile genuineness was theoretically the more important variable, we decided to focus on this variable and report results for smile genuineness only, not considering perceived spontaneity. The same applied to the regression analyses in which the results were identical for measures of spontaneity and genuineness. Ratings of spontaneity and genuineness were associated with those of amusement ($rs > .46, p < .001$). However, correlation coefficients were lower than those between spontaneity and genuineness, suggesting that these two measures tap related but different aspects of smile perception.
univariate analyses (spontaneous, genuine, amused), we applied a Greenhouse–Geisser adjustment to degrees of freedom. The sex of participant main effect was not significant, $F(3, 48) = 0.37, p > .05$, $\eta_p^2 = .02$. As expected, there was a main effect for smile, $F(12, 39) = 32.16, p < .001, \eta_p^2 = .91$. It was significant for all three variables: spontaneous, $F(2.87, 143.74) = 27.08, p < .001, \eta_p^2 = .35$; genuine, $F(3.09, 154.40) = 27.93, p < .001, \eta_p^2 = .36$; and amused, $F(3.17, 158.46) = 135.35, p < .001, \eta_p^2 = .73$.

Post hoc comparisons showed that spontaneous D smiles were generally rated as more genuine ($M_{\text{diff}} = 0.94, SE_{\text{diff}} < 0.18, ps < .001$) and amused ($M_{\text{diff}} = 1.28, SE_{\text{diff}} < 0.12, ps < .001$) than ND smiles, in accordance with previous findings (Frank et al., 1993; Gosselin, Beaupré, & Boissonnault, 2002; Gosselin, Perron, et al., 2000; Hess & Kleck, 1994; Messinger et al., 2008). It is interesting that participants also distinguished between more intense and less intense D smiles within the spontaneous condition. More intense D smiles (i.e., pronounced) were judged as more genuine ($M_{\text{diff}} = 0.42, SE_{\text{diff}} = 0.12, p < .05$) and more amused ($M_{\text{diff}} = 0.82, SE_{\text{diff}} = 0.08, p < .001$) than were D smiles of lower intensity (i.e., moderate; see Table 1, Experiment 2). Extending previous research (Bolzani Dinehart et al., 2005; Hess et al., 1997; Messinger et al., 2008), these findings show that expression intensity leads to differences in how spontaneous D smiles are perceived. The higher the intensity of the expression, the more genuine and amused the associated spontaneous D smile was perceived to be.

A different pattern of results was found for deliberate smiles. Here, participants did not differ in their judgments of the genuineness of D and ND smiles ($M_{\text{diff}} = 0.19, SE_{\text{diff}} = 0.18, p > .05$), showing that they perceived these two types of smile as equally insincere. They nevertheless made higher amusement ratings of D than of ND smiles ($M_{\text{diff}} = 1.05, SE_{\text{diff}} = 0.12, p < .001$), thereby providing some support for the notion that D smiles convey greater positive emotionality.

Post hoc comparisons showed that there was a significant difference in judgments of D smiles made under spontaneous and deliberate conditions. Spontaneous D smiles attracted significantly higher genuineness ($M_{\text{diff}} > 0.70, SE_{\text{diff}} < 0.16, ps < .001$) and amusement ($M_{\text{diff}} > 0.88, SE_{\text{diff}} < 0.09, p < .001$) ratings than deliberate D smiles. This is consistent with the assumption that there is one type of genuine, felt smile: the spontaneous D smile. No such difference emerged for ND smiles (genuine: $M_{\text{diff}} = 0.05, SE_{\text{diff}} = 0.14, p > .05$; amused: $M_{\text{diff}} = -0.17, SE_{\text{diff}} = 0.09, p > .05$), showing that elicitation condition had a significant impact only on judgments of D smiles.

**Regression Analyses**

Multiple regression analyses were used to examine the degree to which each of the facial features (D marker, asymmetry, irregularity, onset time, apex time, offset time, nonpositive facial actions) predicted ratings of spontaneity, genuineness, and amusement. Table 2 (Experiment 2) shows the beta coefficients associated with these seven predictors. Apex duration ($ps < .05$), nonpositive facial actions ($ps < .05$), and asymmetry ($ps < .05$) were significant predictors of how genuine and amused the smile was perceived to be. The longer the apex duration and the fewer nonpositive facial actions, the more genuine and amused a smile was judged to be. Less asymmetry was also associated with higher ratings of smile genuineness. Thus, symmetrical smiles were associated with higher ratings of genuineness of the expression. The presence or absence of the D marker did not significantly predict any of the ratings, nor did irregularity, onset time, or offset time ($ps > .05$).

**Experiment 3**

Our aim in Experiment 3 was to investigate whether judgments of smiles would be affected by having access to the upper or lower face. Research on the relative importance of the upper and lower face has shown either the mouth region (Bassili, 1979; Kerstenbaum, 1992) or both the mouth and the cheeks (Boucher & Ekman, 1975; Kohler et al., 2004; Nusseck, Cunningham, Wallraven, & Bülthoff, 2008) to be crucial to the recognition of happiness. However, these studies did not specifically examine D smiles. Williams, Senior, David, Loughland, and Gordon (2001) showed more frequent and longer eye fixations to the crow’s feet area in

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**Table 1**

**Means and Standard Errors for Ratings of Genuineness and Amusement as a Function of Condition and Smile Type in Experiments 2, 3, and 4**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Spontaneous</th>
<th>Deliberate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duchenne (b)</td>
<td>Duchenne (a)</td>
</tr>
<tr>
<td>Experiment 2 (n = 53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genuine</td>
<td>4.42</td>
<td>0.12</td>
</tr>
<tr>
<td>Amused</td>
<td>3.84</td>
<td>0.10</td>
</tr>
<tr>
<td>Experiment 3 (n = 50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genuine</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Amused</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Experiment 4 (n = 60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genuine</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Amused</td>
<td>—</td>
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</tr>
</tbody>
</table>

Note. Duchenne (a) = pronounced, more intense smiles; Duchenne (b) = moderate, less intense smiles. All ratings were made on 1-to-7 Likert scales, with higher scores indicating greater levels of that dimension. Row means with different subscripts differ at $p \leq .05$ or better.
the upper face of D smiles, but their findings pertain to comparisons with nonexpressive faces rather than with ND smiles. Tremblay et al. (1993) used image manipulation techniques to vary the presence or absence of the D marker in still photographs of smiling or neutral faces. Although crow’s feet (a distinctive feature of D smiles) influenced perceptions of smile genuineness, this was only true in the case for medium intensity smiles. In general, the intensity of mouth region activity was most indicative of a genuine smile expression.

We examined the relative importance of the upper and lower part of the face in dynamic D and ND smiles made under spontaneous and deliberate conditions. Participants were presented with partial faces that showed either the upper or the lower face. Given that the D marker is a feature of the upper face, it should play a significant role in the distinction between D and ND smiles only in the upper face. Differences in ratings of genuineness and amusement of D and ND smiles should therefore be absent or at least attenuated when judges have access solely to the lower face.

Method

Participants

Fifty-one undergraduate students (22 men, 29 women), ages 18 to 34 years (M = 20.57 years, SD = 2.84) at Cardiff University took part individually either for course credit or for a payment of £3.

Stimulus Material and Design

The smile stimuli were the same as those used in Experiment 2, except that only spontaneous D smiles of higher intensity (pronounced) were included. This resulted in a design with four smile types: (a) 6 spontaneous D smiles, (b) 6 spontaneous ND smiles, (c) 6 deliberate D smiles, and (d) 6 deliberate ND smiles. Smile type (D, ND) and condition (spontaneous, deliberate) were treated as two independent factors. Two partial face versions were created for each of the 24 expressions, showing either the lower or upper face with the other half covered by a black mask. Lower face versions showed the mouth area only, including the nasolabial furrows. Upper face versions showed the eye area only, including the cheek bulges. The resulting 48 facial stimuli were displayed as movie clips in MediaLab (Empirisoft) and shown in random order.

Procedure and Dependent Variables

These were the same as in Experiment 2, except that participants were told that for each stimulus person only the lower or upper part of the face would be visible. The dependent variables were identical to those used in Experiment 2.

Analysis of Variance

The three dependent measures were entered into a MANOVA, with face (lower, upper), condition (spontaneous, deliberate), and smile type (D, ND) as within-subjects factors, and sex of participant (male, female) as a between-subjects factor. The main effect of sex of participant was not significant, F(3, 47) = 2.60, p > .05, \( \eta^2_p = .14 \). A significant main effect was found for face, F(3, 47) = 10.65, p < .001, \( \eta^2_p = .40 \). This was significant only for ratings of amusement, F(1, 49) = 8.31, p < .01, \( \eta^2_p = .14 \). Smiles shown in the lower face attracted significantly higher amusement ratings (M = 3.53) than those shown in the upper face (M = 3.38). This is consistent with the notion that the lower face is more influential in shaping attributions of happiness and amusement (Bassili, 1979; Kerstenbaum, 1992; Tremblay et al., 1993). An upward turning mouth therefore appears to be the strongest determinant of how much amusement smiles are seen as conveying.

Significant main effects also emerged for condition, F(3, 47) = 11.49, p < .001, \( \eta^2_p = .42 \), and smile type, F(3, 47) = 105.66, p < .001, \( \eta^2_p = .87 \). These two main effects were qualified by a significant interaction between condition and smile type, F(3, 47) = 31.64, p < .001, \( \eta^2_p = .67 \). The interaction was significant for all three dependent variables: spontaneous, F(1, 49) = 23.35,
As in Experiment 2, judgments of D smiles varied significantly between the spontaneous and deliberate conditions. In particular, spontaneous D smiles attracted higher ratings of genuineness, $F(1, 49) = 43.19, p < .001, \eta^2_p = .47$, and amusement, $F(1, 49) = 85.56, p < .001, \eta^2_p = .64$, than did deliberate D smiles. Recapturing the findings of Experiment 2, this supports the notion that there is just one type of genuine felt smile, namely the spontaneous D smile.

Elicitation condition did not influence the perceived genuineness of ND smiles, $F(1, 49) = 0.35, p > .05, \eta^2_p = .01$. However, participants judged deliberate ND smiles to be more amused than spontaneous ones, $F(1, 49) = 10.67, p < .01, \eta^2_p = .18$. Whereas D smiles are perceived as reflecting greater amusement when they are shown spontaneously rather than deliberately, the opposite is true for ND smiles.

Unexpectedly, these effects were not qualified by the face variable. The interaction between face and smile type was not significant, $F(3, 47) = 1.83, p > .05, \eta^2_p = .10$. Thus, the differences between ratings of D and ND smiles did not vary as a function of whether the upper or the lower face was shown. This seems odd given that the principal physical difference between D and ND smiles is visible only in the upper face. As we will see in the regression analyses, however, other features contributed to participants’ ratings, and these may have enabled them to distinguish between smile types simply on the basis of the lower face.

Regression Analyses

Multiple regression analyses showed that the pattern of results varied depending on whether the lower or upper face was shown (see Table 2, Experiment 3). As expected, in the upper face condition only the D marker was a significant and positive predictor of how genuine and amused ($ps < .05$) the smile was perceived to be. However, other features were significant predictors of ratings made in the lower face condition. Here, apex duration ($ps < .05$) and asymmetry ($ps < .05$) were associated with ratings. As in Experiment 2, the longer the apex duration, the more genuine and amused the smile was perceived to be. In addition, the less asymmetrical the smile was, the more genuine it was seen to be. Given that apex duration and asymmetry differed between the smile types (see above), these features may have contributed not only to overall ratings of genuineness and amusement in the lower face, but also to the distinction between D and ND smiles. Thus, the role played by the D marker in judgments of the upper face seems to have been taken over by asymmetry and apex duration when only the lower face was visible.

Experiment 4

Our aim in this study was to examine whether judgments of smiles would be affected by seeing static images versus dynamic displays. Several studies have shown that dynamic information increases the recognition of emotional expressions (Ambadar, Schooler, & Cohn, 2005; Bassili, 1979; Bould & Morris, 2008; Bruce & Valentine, 1988; Wehrle, Kaiser, Schmidt, & Scherer, 2000) and influences perceptions of the naturalness and spontaneity of expressions (Krumhuber & Kappas, 2005; Sato & Yoshikawa, 2004). These benefits of dynamic displays were found to be due to the motion signal itself rather than additional static information contained in moving sequences. Ambadar et al. (2005) and Bould and Morris (2008) showed that “multistatic sequences,” containing the same number of frames as dynamic images but with a mask between each frame to prevent apparent motion, were recognized with lower accuracy than dynamic displays.

We used a similar paradigm in which participants were presented with either multistatic images or dynamic displays of spontaneous and deliberate D and ND smiles. Bearing in mind that the D smile is defined in terms of its morphology, we expected perceivers to be able to distinguish between D and ND smiles regardless of whether the smiles were static or dynamic. However, the ability to distinguish between spontaneous and deliberate smiles should be impaired when seeing static displays because dynamic information concerning the spontaneity and genuineness of a smile is absent. Participants should therefore distinguish between spontaneous and posed smiles only when exposed to dynamic faces, with spontaneous smiles being rated as more genuine and amused.

Method

Participants

Sixty undergraduate students (30 men, 30 women), ages 18 to 32 years ($M = 22.35$ years, $SD = 3.46$) at Cardiff University took part individually in this study either for course credit or for a payment of £2. Half were randomly allocated to the static mode, the other half to the dynamic mode.

Stimulus Material and Design

The same four smile types as in Experiment 3 were employed: (a) 6 spontaneous D smiles, (b) 6 spontaneous ND smiles, (c) 6 deliberate D smiles, and (d) 6 deliberate ND smiles. In the dynamic mode condition, these 24 smiles were shown to the participants as video clips. In the static mode condition, each smile was represented by a sequence of five still images extracted from the video sequences. Images reflected the time course of the expression and showed a neutral face (first frames), followed by the smile halfway through its onset (frame at midpoint from the start of the smile to its peak), at its apex (frame at peak intensity), halfway through its offset (frame at midpoint from the decrease of the smile to its neutral position), and a neutral face (last frames) at the end. These five images were displayed for the same total duration as the corresponding clips in the dynamic mode. To prevent any perception of motion in the static sequences, we separated successive pairs of static images by a blank screen that lasted 5 frames. The resulting 24 sequences of static images were shown to all partici-
Participants in the static mode condition. In both conditions (static and dynamic), stimuli were presented in random order via MediaLab (Empirisoft).

Procedure and Dependent Variables

The procedure in the dynamic condition was identical to that in Experiment 2. In the static condition, participants were instructed as follows: “What you are going to see is a series of still images, each of which depicts a person expressing a spontaneous or posed smile. Each picture in the set shows one segment of the smile episode. The pictures are separated by a blank screen. In total, you will only see 5 still pictures of each episode. The duration for which the pictures are displayed will vary.” Further instructions regarding the nature of spontaneous and deliberate smiles, as well as the experimental task and procedures for responding, were the same as in the previous studies. The dependent variables were the same as those used in Experiments 2 and 3.

Results and Discussion

Analysis of Variance

A MANOVA with condition (spontaneous, deliberate) and smile type (D, ND) as within-subjects factors and display mode (static, dynamic) and sex of participant as between-subjects factors was conducted on the three dependent variables. The main effect of sex of participant was not significant, F(3, 54) = 2.29, p > .05, ηp² = .11. There was a significant main effect of display mode, F(3, 54) = 3.53, p < .05, ηp² = .16. This was significant only for amusement, F(1, 56) = 5.87, p < .05, ηp² = .09. Overall, static displays attracted significantly higher amusement ratings (M = 3.64) than did dynamic displays (M = 3.36).

Consistent with expectations, there was a significant interaction between condition and display mode, F(3, 54) = 7.43, p < .001, ηp² = .29. It was significant for all three variables: spontaneous, F(1, 56) = 21.41, p < .001, ηp² = .28; genuine, F(1, 56) = 15.06, p < .001, ηp² = .21; and amused, F(1, 56) = 14.34, p < .001, ηp² = .20. Paired samples t tests showed that participants discriminated between spontaneous and deliberate smiles in the dynamic, but not in the static, mode. As can be seen in Figure 1, spontaneous smiles were rated as more genuine, t(29) = 3.94, p < .001, and amused, t(29) = 5.38, p < .001, than deliberate smiles. No such difference emerged for static displays—genuine, t(29) = –1.03, p > .05; amused, t(29) = 0.22, p > .05—indicating that significant information about the spontaneity of the expression was not transmitted via static cues. The finding is consistent with previous research and suggests that dynamic displays convey information relevant to expression perception over and above that contained in static representations (see Ambadar et al., 2005; Wehrle et al., 2000).

There was also evidence that participants were misled by the static representations. Independent samples t tests showed that significantly higher ratings of genuineness, t(58) = 2.78, p < .01, and amusement, t(58) = 3.69, p < .001, were given to deliberate smiles, and that spontaneous smiles were perceived as less genuine when shown in the static compared with the dynamic mode, t(58) = –1.98, p ≤ .05. This shows that static displays resulted in less accurate judgments of both spontaneous and deliberate smiles and also to an overattribution of emotion in the case of deliberate smiles.

The influence of the D marker should not depend on whether a face is static or dynamic. Indeed, the effect of the presence or absence of this marker was not moderated by display mode. There were significant main effects for condition, F(3, 54) = 6.35, p < .01, ηp² = .26, and smile type, F(3, 54) = 115.78, p < .001, ηp² = .86. These were qualified by a significant interaction between condition and smile type, F(3, 54) = 17.71, p < .001, ηp² = .50. The interaction was significant for all three dependent measures: spontaneous, F(1, 56) = 24.44, p < .001, ηp² = .30; genuine, F(1, 56) = 34.25, p < .001, ηp² = .38; and amused, F(1, 56) = 53.81, p < .001, ηp² = .49. Analyses of simple effects revealed that both spontaneous and deliberate D smiles were rated as more genuine—spontaneous, F(1, 56) = 57.94, p < .001, ηp² = .51; deliberate, F(1, 56) = 5.44, p < .05, ηp² = .09—and amused—spontaneous, F(1, 56) = 228.24, p < .001, ηp² = .80; deliberate, F(1, 56) = 109.42, p < .001, ηp² = .66—than ND smiles (see Table 1, Experiment 4), thereby replicating the findings of Experiment 3.

Comparing smile types across elicitation condition, spontaneous D smiles were judged to be significantly more genuine, F(1, 56) = 29.71, p < .001, ηp² = .35, and amused, F(1, 56) = 62.15, p < .001, ηp² = .53, than deliberate D smiles were. This is in line with the two previous studies and shows the critical role played by condition in shaping the perceived quality of D smiles.

It is interesting that participants’ ratings of ND smiles also varied as a function of elicitation condition, such that less genu-

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Figure 1. Genuineness and amusement ratings of spontaneous and deliberate smiles in the static and dynamic conditions of Experiment 4. Error bars show standard errors.
ineness, $F(1, 56) = 3.89, p \leq .05$, $\eta^2_p = .06$, and amusement, $F(1, 56) = 7.01, p < .05$, $\eta^2_p = .11$, were attributed to spontaneous than to deliberate ND smiles. The finding provides further evidence of opposing effects on judgments of D and ND smiles. Among ND smiles, those made deliberately appear more genuine and as reflecting greater amusement than those made spontaneously.

**Regression Analyses**

Multiple regression analyses showed that the results varied as a function of static and dynamic displays (see Table 2, Experiment 4). For dynamic displays, the same three facial features as in Experiment 2 emerged as significant predictors: apex duration ($ps < .05$), asymmetry ($ps < .01$), and nonpositive facial actions ($ps < .05$). The longer the apex, the more genuine and amused the smile was judged to be. Similarly, less asymmetry and fewer nonpositive facial actions were associated with higher ratings of genuineness and amusement. For static displays, only nonpositive facial actions ($ps < .05$) and the D marker ($ps < .05$) significantly predicted judgments. Higher ratings of amusement were given to smiles characterized by fewer nonpositive facial actions and by the D marker. Similarly, fewer nonpositive facial actions were associated with increased ratings of smile genuineness.

**General Discussion**

The aim of this research was to test the value of the D smile as a spontaneous and genuine sign of enjoyment. It has been argued that D smiles signal spontaneous, felt emotions that differ from posed or false smiles with respect to the presence of AU 6. In the present research, we explored the reliability and validity of the D smile with respect to both expression and perception. In Experiment 1, we focused on expression and investigated whether people were able to activate the orbicularis oculi, pars lateralis muscle (AU 6) to produce a voluntary D smile and how frequently they did so. We examined whether D smiles occur solely or predominantly under spontaneous conditions, and whether ND smiles occur solely or predominantly under deliberate conditions. Participants either spontaneously smiled in reaction to genuinely amusing stimuli (spontaneous condition) or were instructed to pose a smile expression (deliberate condition). It is interesting that there were similar proportions of smiles with and without the D marker, AU 6, in these two conditions. Thus, senders could produce D smiles deliberately, and they did so quite often. Furthermore, not all the observed ND smiles were posed; some occurred in the spontaneous condition. These findings are in line with increasing evidence that D smiles and ND smiles can occur under both spontaneous and deliberate conditions (Schmidt & Cohn, 2001; Schmidt et al., 2006, 2009; Smith et al., 1996) and cast doubt on claims that D smiles are spontaneous signs of felt enjoyment that cannot be feigned (Ekman, 1985, 1989, 1993).

Whether a D or ND smile was shown was less a function of the spontaneity of the expression than of the intensity of the smile. D smiles were more intense than ND smiles, and when they were made deliberately, they were even more intense than D smiles made in the spontaneous condition. This is consistent with observations that D smiles tend to involve stronger smiling actions than ND smiles and that they covary with the degree of smile strength (Ekman & Friesen, 1978; Frank et al., 1993). In a recent study by Messinger et al. (2008), changes in smile intensity were also found to be linked to changes in eye constriction (AU 6). That is, the more intense the smile expression, the higher was the probability of a D smile. Messinger et al. (2008) consequently suggested treating AU 6 in D smiles not as a dichotomous signal that distinguishes D from ND smiles (see Abe, Beetham, & Izard, 2002; Messinger, 2002; Messinger et al., 1999, for similar claims), but rather as an ordinally graded index of smile intensity. An important source of such association may be muscular synergies (Messinger et al., 2008). That is, as the zygomaticus major muscle pulls the lip corners upward, it raises the cheeks toward the eyes. These synergies provide a basis for explaining the effects of expression intensity by linking the occurrence of AU 6 directly to the intensity of the smiling action (AU 12).

Self-reports of positive experience varied as a function of both elicitation condition and smile type. Higher ratings accompanied D smiles occurring in the spontaneous condition than in the deliberate condition. This supports the notion that only the spontaneous D smile reflects genuine enjoyment (Ekman et al., 1988, 1990; Frank et al., 1993). By contrast, in the deliberate condition senders were able to produce D smiles that did not reflect felt positive affect. Whether made spontaneously or deliberately, however, D smiles were associated with more positive emotion than ND smiles, suggesting that this relation holds even when a D smile is being posed. A possible avenue for future research would be to study the relation between D smiles and emotional experience under varying conditions, including negative ones. Whereas Bonanno and colleagues (Keltner & Bonanno, 1997; Papa & Bonanno, 2008) showed that D smiles led to less negative feelings on the part of individuals talking about their recently deceased spouse or in response to a negative affect manipulation during a monologue task, such mitigation of negative affect by D smiles was not found by Soussignan (2002). Moreover, the content of participants’ talk in the monologue task (Papa & Bonanno, 2008) and the bereavement interview (Keltner & Bonanno, 1997) during which facial behaviors were measured was not taken into account. An important step, therefore, would be to conduct a time-based analysis of facial behavior in order to clarify the extent to which D smiles serve a self-regulatory function. Preliminary work of this nature has already been done by Wagner and Lee (1999; see also Lee & Beattie, 1998), who tracked the occurrence of D and ND smiles in relation to specific events in time. These researchers found considerable D smiling accompanying negative statements. Further research is clearly needed to shed more light on the intrapersonal consequences of D smiles.

In Experiments 2–4, we focused on the perception of smiles. Specifically, we examined how genuine and amused D and ND smiles were judged to be, and whether people distinguished be-
between these two smile types when they were made under spontaneous and deliberate conditions. In each study, we also investigated the predictive value of the D marker alongside other smile attributes such as asymmetry; irregularity; onset, apex, and offset durations; and nonpositive facial actions. If the D marker is indeed the most diagnostic symptom of a felt smile, we expected its capacity to predict perceivers’ ratings of the smiles to be consistent and at least as great as the predictive value of the other smile attributes.

Participants generally rated spontaneous and deliberate smiles differently. In all three studies, the spontaneous D smile was rated as most genuine and amused, consistent with the notion that this type of smile is perceived as expressing felt positive emotion (Frank et al., 1993; Gosselin, Beaupré, & Boissonneault, 2002; Gosselin, Perron, et al., 2002). In Experiment 2, perceivers also distinguished between spontaneous D smiles that varied in intensity. D smiles of higher intensity were judged to reflect greater subjective enjoyment than D smiles of lower intensity. This shows that the intensity of the expression made by a sender significantly affected how spontaneous his or her D smiles were perceived to be and extends previous research on the effects of expression intensity (e.g., Bolzani Dinehart et al., 2005; Hess et al., 1997; Messinger et al., 2008).

In Experiment 3, perceivers were shown either the upper or the lower face. Contrary to expectations, similar ratings were made when seeing the upper or lower face, showing that judges were able to use cues other than the D marker itself to distinguish between D and ND smiles. In Experiment 4, perceivers saw static or dynamic versions of the smiles, and this had a significant impact on judges’ ratings. When smiles were presented in their dynamic form, spontaneous smiles were judged as more genuine and amused than deliberate smiles. However, this difference did not emerge for static displays. This is consistent with past research on dynamic displays (Ambadar et al., 2005; Wehrle et al., 2000) and shows that dynamic information contains important cues concerning the spontaneity of the expression.

In comparing the utility of several physical attributes of smiles in predicting how smiles were judged, we found that asymmetry of expression and apex duration were consistent predictors across the three studies. The less asymmetric the smile was and the longer its apex duration, the more genuine and amused it was judged to be. The presence of nonpositive facial actions also significantly predicted judgments, with smiles being rated as more genuine and amused when they had fewer nonpositive facial actions, such as frowning and lip pressing. These findings extend previous research (Ambadar et al., 2009; Gosselin, Beaupré, & Boissonneault, 2002; Gosselin, Perron, et al., 2002; Krumhuber & Kappas, 2005) and suggest that all three variables contribute to how smile expressions are evaluated. It is interesting that the predictive utility of the D marker was rather limited. It only significantly predicted ratings when judges saw the upper face or when they viewed static rather than dynamic displays. Furthermore, in the case of static displays, the D marker predicted only how amused (but not how genuine) the smile was judged to be. These results call into question the received wisdom that the D marker is the most reliable index of felt positive emotion (Frank & Ekman, 1993). Our findings point to a different conclusion, namely that the D marker is one among several attributes that lead judges to regard smiles as genuine and as reflecting amusement. In the present research, the D marker was not the most diagnostic attribute, nor was it a consistent cue for rating smiles as expressing spontaneous amusement.

Much of our current understanding of facial expressions of emotion derives from research using static facial images (Russell, Bachorowski, & Fernández-Dols, 2003). A distinction is often drawn between “spontaneous” and “deliberate” smiles on the basis of the presence or absence of the D marker. Clearly, this morphological marker is discernible in static displays and, as the present research shows, it has reliable effects on how smiles are judged on the basis of static images. In everyday life, however, judgments of the genuineness of smiles are made on the basis of dynamic expressions, and the evidence from the present research is that the D marker is a less important cue when dynamic information is available. Future research should focus on dynamic displays and consider a broader range of behavioral cues than the D marker.

A feature of the present work that might be regarded as a limitation stems from the way in which we equated smile intensity across conditions in the three judgment studies, with D and ND smiles being of comparable intensity in both the spontaneous and deliberate conditions. There is no doubt that expression intensity influences the perceived intensity of the associated emotion (see Bolzani Dinehart et al., 2005; Hess et al., 1997; Messinger et al., 2008). However, in the present research, we wanted to rule out differences in smile intensity as a possible explanation for differential responses to smiles in the spontaneous and deliberate conditions. We therefore kept this variable constant across conditions and considered the effects of expression intensity separately in Experiment 2, where we examined the perception of D smiles that differed in intensity within the spontaneous condition. Future research could include a broader range of variation in smile intensity and examine whether the influence of other physical attributes such as the ones studied in the current research is moderated by smile intensity.

In conclusion, we have shown that D smiles occurred as both felt and posed expressions, and that the presence or absence of the D marker was not the only basis on which those who judged smiles made ratings of genuineness and amusement. The role of the D marker, AU 6, therefore needs to be reconsidered. The D smile is operationalized as the combination of AUs 6 and 12. It is clear that D smiles can and do occur when the individual experiences genuine amusement. However, it is not the case that all smiles involving the D marker reflect genuine amusement. D smiles also occur when the individual poses amusement and are even shown under negative emotional circumstances. The usefulness of facial muscle units such as AUs 6 and 12 in identifying whether a smile expresses enjoyment is therefore thrown into doubt. The evidence from the present research is that the D marker by itself is not a reliable basis for inferring whether a smile is spontaneous, genuine, or reflective of subjective amusement.

References


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