School of Psychology
Cardiff University, UK

TEMPORAL ASPECTS OF FACIAL DISPLAYS

Eva G. Krumhuber

Supervisor:
Prof. Antony S. R. Manstead

Cardiff, 7 November 2007

This dissertation is submitted for the degree of Doctor of Philosophy

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

School of Psychology

Cardiff University, UK

School of Psychology

TEMPORAL ASPECTS OF FACIAL DISPLAYS

Eva G. Krumhuber

Supervisor:

Prof. Antony S. R. Manstead

Cardiff, 7 November 2007

This dissertation is submitted for the degree of Doctor of Philosophy

"...Facial movement of expression (which) impresses us through its changes, through its melody. The characteristic of the person will always be the way they move, the melody of the expression; this can never be caught in snapshots..."

(Sir Ernst Gombrich, cited by Jonathan Miller, 1983)

Name: Eva Krumhuber
Dissertation Title: Temporal aspects of facial displays

ABSTRACT

A limitation of much past research on facial expression of emotion is its focus on static facial images. The research reported in the present dissertation was designed to examine the role played by dynamic information in the interpretation of facial expressions, particularly with respect to their perceived authenticity. In a first set of studies, the dynamic properties (i.e., onset, apex, and offset durations) of smiles were manipulated in the context of two social settings. Using a simulated job interview situation, the studies reported in Chapter 2 show that temporal aspects of smiles significantly influenced judgements made about interviewees. Comparable effects were found for synthetic and human faces. In the studies reported in Chapter 3, the impact of dynamic aspects of smiles was investigated in the context of two trust games with financial stakes. Choice of counterpart and decisions to cooperate with another person in the game were influenced by the dynamic quality of counterparts' smiles. These effects of facial dynamics on cooperative behaviour were shown to be mediated by the perceived trustworthiness of the other player. Focusing on real smiles, the research in Chapter 4 explored the role of the Duchenne smile in the expression and perception of spontaneous and posed smiles. In comparison to dynamic aspects, the signal value of the Duchenne marker was found to be limited and significant only for ratings of the upper face and of static displays. The study reported in Chapter 5 examined the role of smiles with different temporal dynamics in moderating judgements of emotional utterances. Smiles significantly influenced perceptions of emotional state evoked by the utterances and led to different attributions depending on whether anger or disgust was conveyed verbally. In sum, the findings illustrate that dynamic properties convey important information that is detected accurately and decoded meaningfully by perceivers.

CONTENTS

TABLES

FIGURES

DECLARATIONS

This work has not previously been accepted in substance for any degree and is not concurrently submitted in candidature for any degree.

Signed .... (candidate) Date: 7 November 2007

STATEMENT 1

This thesis is being submitted in partial fulfillment of the requirements for the degree of PhD.

Signed .... (candidate) Date: 7 November 2007

STATEMENT 2

This thesis is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged by explicit references.

Signed .... (candidate) Date: 7 November 2007

STATEMENT 3

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed .... (candidate) Date: 7 November 2007

ACKNOWLEDGEMENTS

Like facial expressions, academic life during a PhD can be described as a phase of continuous motion. To help me face the various challenges of such a time of change, I was fortunate to be surrounded by a group of wonderful people:

I wish to thank my supervisor Tony Manstead for his skillful mentoring and guidance through every step of this dissertation. I could not imagine a more empathic and positive mentor who always encouraged me to higher achievements. His generous nature combined with his research expertise will always be memorable to me and be an asset for my own academic career.

When revising papers for this dissertation, Geoff Thomas was an invaluable source of guidance and inspiration. As my second assessor, his role in providing feedback and suggestions for my research exceeded any reasonable expectations. I am grateful for his support and sharing of ideas.

I also owe thanks to Arvid Kappas, my first and therefore longest mentor in emotion research. Without his intellectual inspiration and critical discussions I would not have got into studying facial dynamics in the first place. His consistent advice and support from the beginning to the end make him the sort of special long-term mentor and friend that every student would like to have.

Throughout the period of my PhD I had the pleasure to present and discuss my work in numerous meetings of the Manstead-Spears lab group. I am very thankful for the contributions and input made by members of this group (i.e., Russell Spears, Martin Bruder, Ronni Greenwood, and Andrew Livingstone). These have added to the richness and vividness of the research enterprise.

I am further indebted to the School of Psychology and their support staff. This research would not have been possible without the technical expertise and laboratory equipment available within the department. I would also like to thank the team of the Graduate Centre and the Student Development Unit at Cardiff University for offering such an interesting programme of training courses. Each of their courses allowed me to develop further my personal and professional skills, which made my academic work more rewarding.

Special thanks go to all the participants, actors, and research students who were involved in one or the other way with my research. Thank you all for your help! Finally, I express my deepest gratitude to my partner, family, and friends. Their warm-hearted smiles and encouraging words provided me with all the love and confidence one can think of. I owe them more than I can say!

Eva Krumhuber 7 November 2007

CHAPTER 1

Temporal Aspects of Facial Displays: An Introduction

A key feature of human facial displays is their dynamic[1] quality. Rather than being a single snapshot, facial expressions are moving displays that are characterised by an unfolding, a peak, and an ending. The temporal structure of facial expressions provides a source of invaluable information that can be extracted in the course of its display. Interestingly, most past research has neglected this dynamic nature of facial expressions (Bruce, Green, & Georgeson, 1996). Studies of facial expressions typically have used static images or photographs at (or very near) the peak of the emotional display. Such frozen snapshots may be sufficient for differentiation between emotions (see Ekman, Friesen, & Ellsworth, 1972). However, these static representations do not reflect the nature and form of dynamic facial expressions as they occur in everyday life. Since the human face is deformed by the activity of facial muscles, and therefore acts in a dynamic way, temporal aspects are likely to play a crucial role in facial expressions of emotions.

Ekman and Friesen (1978) developed what has come to be the most important system for measuring facial behaviour. The Facial Action Coding System (FACS) consists of an inventory of all the visibly distinctive actions that can be produced by the facial muscles. With the use of this tool, Ekman and Friesen (1982b) sought to describe the facial expressions associated with the portrayal of each emotion in terms of minimal observable facial movements. Although the movement aspect is part of this system, interestingly, the dynamic pattern of facial activity has attracted relatively little attention (see Ekman, Friesen, & Hager, 2002). Instead, FACS has been predominantly used in a 'static' way, by coding only the peak of the expressive movement. In addition, the frequency rather than the duration of specific

[1] Please note that the terms *dynamic* and *temporal* will be used interchangeably throughout the dissertation to refer to the motion involved in facial displays.

facial actions, so-called Action Units (AU), at such peak moments has been registered (Ekman et al., 2002), thereby providing a limited view of the dynamic transformation of expressions over time. A result of this 'economic' approach has been a knowledge of facial expressions that is defined almost exclusively by the study of high intensity static 'mug shots' that are devoid of motion (see Ambadar, Schooler, & Cohn, 2005; Bould & Morris, in press)

The present dissertation aims to counterbalance this static tradition by focusing on the role of temporal aspects in facial expressions. There is increasing evidence that facial motion has a powerful impact on the recognition of personal identity (i.e., Ambadar et al., 2005; Kamachi et al., 2001) and the identification or discrimination of emotional expressions (i.e., Lander, Christie, & Bruce, 1999; Pike, Kemp, Towell, & Phillips, 1997; also, see later chapters). Interestingly, the influential role of dynamic information in the interpretation of an expression is still in need of exploration, particularly with respect to possible differences between genuinely felt expressions and 'false' ones that are deliberately posed (see Ekman & Friesen, 1982a). The central objective of the work reported in this dissertation is to reveal the importance of dynamic aspects with respect to the truthfulness or deceitfulness of smile expressions. Such a question addresses the wider context of facial motion by asking whether facial dynamics reveal information about the emotion-eliciting event.

The present chapter is organised as follows. First, the effects of dynamic aspects of facial expression in identity and emotion recognition are considered, thereby suggesting possible parallels in the more general effects of facial dynamics. This is followed by a short overview of the role played by dynamic and morphological markers in differentiating between genuinely felt and false smiles. Literature on the perception of dynamic aspects of smile expressions is then reviewed, and possible limitations are addressed. The chapter concludes with a summary of the outstanding questions that need to be addressed and with an outline of the chapters that follow.

Facial Dynamics in Identity Recognition

The influence of motion on the recognition of identity was demonstrated in early studies using point-light displays. By attaching lights to a walker's major joints, Johansson (1973, 1976) showed that perceptions of a moving human could be readily achieved from the dynamic configuration of as few as six point-light sources attached to the person. Not only could a human figure be seen, but the posture, gait and body movements (i.e., walking, running, jumping) could be clearly described. Bassili (1978) adapted Johansson's technique to show that observers could identify a face more often from a moving configuration of lights than from a static series. In a similar vein, Bruce and Valentine (1988) demonstrated superior identity recognition rates for dynamic compared to still point-light displays of faces. Dynamic information therefore seems to contribute to person recognition, particularly where the static cues are impoverished, as they are in biological motion representations (see also O'Toole, Roark, & Abdi, 2002).

This assumption is supported by findings showing a motion advantage across different types of degraded faces. Lander and colleagues (1999) found that movement significantly improved recognition of famous faces that had been degraded by inversion, negation or thresholding. When showing normal unfamiliar faces, however, no recognition benefit emerged for dynamic faces (Christie & Bruce, 1998). Knight and Johnston (1997) demonstrated that motion significantly improved recognition of famous faces, but only when the image quality was severely reduced by presenting photographic negatives. When faces were presented as positive images, there was no significant effect of movement on recognition of either upright or inverted faces. On the basis of these findings, it was suggested that movement may provide crucial evidence about its three-dimensional structure of the face (Pike et al., 1997), thereby compensating for the impoverished depth cues within degraded faces (Knight & Johnston, 1997).

In subsequent studies, Lander and colleagues (1999) showed that the recognition advantage for degraded moving images was not due solely to the increased amount of static information contained in a moving sequence. Equating the amount of static information in the static and moving sequences (by presenting the same number of frames) did not remove the recognition advantage for moving images. Similarly, Pike and colleagues (Pike et al., 1997) found that increasing the number of angles of view (with 10 distinct viewpoints) in multiple static images did not lead to recognition rates comparable to those obtained in the dynamic moving sequence. This was shown to be the case even when static cues were not degraded. The advantage conferred by motion cues is therefore not a product of the increased number of static images or perspective views. Instead, the dynamics of the motion seem to provide additional information, over and above that contained in static images.

Interestingly, the precise dynamic characteristics of the observed motion play an important role in mediating the recognition advantage provided by motion. Changing the dynamics of the motion either by slowing down the dynamics or by changing their rhythm significantly reduced recognition rates of degraded face images (Lander et al., 1999). This effect was replicated for repetition priming with normal faces, in which the biggest priming advantage was found with naturally moving faces, rather than with those shown in slow motion (Lander & Bruce, 2004). Thus, the relatively accurate recognition of faces that are shown with their original dynamic properties seems to imply that motion information has intrinsic value in face representations.

In further experiments, enhanced priming effects of known and unknown normal faces were shown, regardless of whether the test image was moving or static (Lander & Bruce, 2004), or whether there was a difference in expression or viewpoint between prime and test images (Thornton & Kourtzi, 2002). By creating an average head that was animated with movements captured from real people, Hill and Johnston (2001) demonstrated that facial motion alone (in the absence of spatial cues) was sufficient for categorising sex and identity. Interestingly, rigid translations and rotations of the head appeared particularly useful for categorising identity, while non-rigid facial motion (i.e., relative motion of individual facial features caused by changes in facial expression) was more useful for categorising sex. In another study using computer animated heads, Knappmeyer, Thornton, and Bülthoff (2003) showed that the characteristic motion associated with each of two faces during learning biased observers' identity decisions about an animated face (consisting of a morph of the two faces) even when relevant form cues pointing to each person's facial identity were available.

Together, these findings suggest that motion carries important information about identity that allows the establishment of person specific (idiosyncratic) representations. The recognition advantage provided by motion information is found above and beyond the extra static information and perspective views that are available from a moving image. Moreover, motion information aids recognition even if static cues can be employed to produce accurate recognition rates and when relevant form cues are available. Movement also aids in the derivation of a 3D structure of the face, particularly when images are degraded, but similarly contributes in a sufficient way to recognition when spatial cues are absent. Lastly, the individual characteristics of motion are important and intrinsic to face representations, with faces that move naturally providing the greatest advantage for identity recognition.

Facial Dynamics in Emotion Recognition

Just as for identity recognition, facial motion has been shown to provide important information for the differentiation of emotions. Using point-light displays, Bassili demonstrated that emotional expressions (i.e., happiness, sadness, surprise) could be recognised at above chance levels on the basis of facial movement alone (Bassili, 1978), and more accurately than when shown under static conditions (Bassili, 1979). Applying the same technique, Bruce and Valentine (1988) found higher identification rates of facial expressions in dynamic than still point-light displays. Indeed, the information provided by the movement of the surface of the face was sufficiently rich to specify the type of emotion displayed.

Motion signals have been claimed – as in the case of identity recognition – to be especially useful when static stimuli are limited in nature (e.g., through degradation, or lack of intensity; Bould & Morris, in press). In a study by Wehrle and colleagues (Wehrle, Kaiser, Schmidt, & Scherer, 2000) schematic line drawings of faces were produced that showed the relevant emotional info purely in the form of appraisal specific action patterns. The authors showed that dynamic presentations of these facial actions significantly increased overall recognition accuracy and reduced confusions between unrelated emotions. However, this difference was larger for subtle expressions than intense ones. Moreover, the frame numbers and dynamic properties of the moving sequences were varied together, thereby confounding the effect of motion with those of extra-static information.

To address this problem, subsequent studies tested whether any emotion recognition benefit of movement was due to the motion signal itself, rather than additional static information. Both Ambadar and colleagues (Ambadar et al., 2005) and Bould and Morris (in press) compared a dynamic sequence with a multistatic sequence that contained the same number of frames, but with a mask between each frame to disrupt the apparent motion. Using normal human faces, they showed that recognition of subtle expressions was significantly better for moving sequences, compared to multistatic and single static sequences. Thus, the motion signal seems to offer more than the sum of additional static information, providing unique temporal information about the facial expressions.

Comparing motion effects for subtle and intense expressions, Bould and Morris (in press) also demonstrated that movement was more important for recognising subtle rather than intense facial expressions. Although movement facilitated recognition to some extent, the motion advantage was reduced when the expressions were of higher intensity. On the basis of these results, it has been suggested that motion may be more important in the recognition of subtle expressions in which the additional information provided by the movement of the face helps to disambiguate the status of the emotion. By contrast, for intense emotions a static face may be a sufficient carrier of the emotional information, thereby making additional cues (such as motion) redundant (Bould & Morris, in press). This helps to explain research findings that have demonstrated minimal or no benefit of movement using intense expressions (Gepner, Deruelle, & Grynfeltt, 2001; Harwood, Hall, & Shinkfield, 1999). The intensity of the facial expression therefore seems to be of relevance in determining any recognition benefits from moving displays.

An important aspect of the perception of subtle emotions is the dynamic changes in these moving expressions (Ambadar et al., 2005; Bould & Morris, in press). Dynamics may enhance individuals' perception of how expressions change over the time. This change through motion, however, does not have to be detected visually. Lederman and colleagues (Lederman et al., 2007) showed that humans are also haptically sensitive to both spatial and temporal changes in facial expressions. By using their hands only, participants could recognise dynamic emotions portrayed by live faces at above chance levels and with greater accuracy and confidence than static displays of facial expressions. Interestingly, such sensitivity to the temporal progression of emotions appears to be relatively in-built and automatic. Edwards (1998) found that participants could accurately reproduce the actual progression of a target person's spontaneous expression from a scrambled set of photographs. In this task, accuracy of the sequence reproduction was inversely related to the amount of time allotted for the task and was significantly greater in the emerging states of an expression. Thus, during such early stages motion cues might be especially informative and adaptively significant to an observer.

As in the case of identity recognition, the velocity of dynamic change of the expressive face plays a significant role in emotion perception. By changing the speed with which an emotion unfolds on the face, Kamachi and colleagues (Kamachi et al., 2001) and Sato and Yoshikawa (2004) showed that observers' judgements varied significantly with the type of emotion displayed. Specifically, slower sequences increased the recognition and perceived intensity of sad expressions, whereas faster sequences resulted in more accurate recognition of happy and surprised faces (Kamachi et al., 2001). Moreover, the perceived naturalness of expressions differed significantly, with slow sequences being rated as most natural for sad and fearful faces, and fast sequences being found to be more natural for surprised faces (Sato & Yoshikawa, 2004). These findings demonstrate that the dynamic properties of facial expressions are important in mental representations of emotions. Changing the motion-specific characteristics of an expression not only affects the way it is recognised, but also how it is evaluated. Because the face moves almost continuously in social encounters, the meaning of the message may vary with the dynamic changes in the signal (Leonard, Voeller, & Kuldau, 1991).

Further studies found effects of facial motion on intensity and realism ratings, such that dynamic expressions were perceived as more intense and realistic than static expressions (Biele & Grabowska, 2006; Weyers, Mühlberger, Hefele, & Pauli, 2006). In addition, facial EMG recordings indicated emotion-specific reactions to moving happy and angry faces, with stronger reactions to dynamic as compared to static expressions (Weyers et al., 2006). Such facial action patterns, interpretable as facial mimicry, were found to occur spontaneously and rapidly in dynamic presentations of emotional faces, but not in the case of static presentations (Sato & Yoshikawa, 2007a). Specifically, the pulling of lip corners and activation of the zygomaticus major muscle (i.e., smiling) were found more frequently in response to happy than angry expressions when these were presented dynamically. Similarly, brow lowering (i.e., frowning) occurred more frequently in response to angry than to happy expressions.

Such facial mimicry in response to moving faces may be essential in detecting the dynamic change in facial expressions of emotions. When mimicking is prevented, Niedenthal and colleagues (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001) showed that participants took significantly longer to detect a change in morphed expressions that changed into a categorically different expression (i.e., happiness changing into sadness, or reverse), as compared with when they were allowed to mimic. Facial mimicry may therefore enable accurate detection of change in dynamic displays and thereby elicit an affective state that is congruent to the expression being perceived (Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000). The dynamic presentation of facial emotions has also been shown to facilitate similar emotional responses in the observer. Sato and Yoshikawa (2007b) found higher arousal responses to dynamic than to static presentations of both happy and fear expressions. Interestingly, the valence ratings were unaffected by presentation type, with similar ratings for static and dynamic stimuli. The dynamic presentation of facial expressions therefore seems to enhance the overall emotional experience without a corresponding qualitative change in the experience (Sato & Yoshikawa, 2007b). Such heightened arousal may account for increased levels of facial mimicry (Sato & Yoshikawa, 2007a; Weyers et al., 2006) as well as higher intensity and realism ratings (Biele & Grabowska, 2006; Weyers et al., 2006) in response to dynamic relative to static displays. This in turn could facilitate the encoding of emotional information from moving displays and thereby lead to the recognition advantage shown for dynamic facial expressions.

To summarise, the findings suggest that facial motion provides a distinct type of information that enables the perceiver to distinguish between various emotional expressions. The beneficial effect of motion is particularly apparent when expressions are subtle rather than intense, and is found over and above the benefits of additional static information contained in moving displays. The perception of dynamic change provides a core and automatic component in this process and changing the rate at which the face moves significantly affects the way in which expressions are recognised and evaluated. Motion signals also evoke spontaneous facial mimicry and lead to higher intensity and realism ratings than do static signals. Such facial and affective responses can be assumed at least partly to be the result of increased emotional arousal experienced when perceiving dynamic expressions.

Felt and False Smiles

Dynamic signals in facial expressions have been shown to provide distinctive information about the emotions expressed. Of these emotions, the smile has received considerable attention because it is one of the most common expressions and is easy to make. Seen as a signal of happiness (Ekman, 1992a, 1994), it not only appears early in life but can also be recognised across different cultures (Ekman, 1989). In terms of facial behaviour, the smile is characterised by the upward pulling of the lip corners which is produced by the *zygomaticus major* muscle. The activation of this muscle is been scored in the Facial Action Coding System (FACS, Ekman & Friesen, 1978), as Action Unit 12 (AU12).

In an early study, Ekman and colleagues showed that the frequency, intensity and duration of AU12 were significantly correlated with the amount of happiness reported (Ekman, Friesen, & Ancoli, 1980a). However, reliance on this single smile movement proved to be insufficient. Not only does the smile occur in positive emotional contexts, but also when experiencing negative emotions such as disgust and fear (Ekman et al., 1980a), disappointment (Kraut & Johnston, 1979), sadness and uncertainty (Klineberg, 1940; LeBarre, 1947, as cited in Frank & Ekman, 1993), and other forms of discomfort (for a review see Ekman, Davidson, & Friesen, 1990).

Due to this lack of a perfect one-to-one relationship between AU12 and positive emotion, Ekman and Friesen (1982a) subsequently proposed that the smile should not be treated as a single behavioural category. Instead, they suggested that a distinction should be drawn between felt emotional smiles, on the one hand, and false smiles deliberately shown to simulate enjoyment when in fact hiding or masking a negative emotion, on the other. Specifically, felt smiles were proposed to occur spontaneously in conjunction with a positive affect, whereas false smiles are posed to convince another person that a positive emotion is felt when it is not (Ekman & Friesen, 1982a). Thus, fake smiles which "obey the will…" are distinct from felt smiles which are "put into play by the sweet emotions of the soul…" (p. 126, Duchenne, 1862/1990). Such genuinely felt smiles have also been termed 'enjoyment smiles' and include all smiles in which the person actually experiences – and presumably would report – a positive emotion (e.g., pleasure, amusement, or delight; Ekman & Friesen, 1982a).

In order to distinguish felt from false smiles in terms of their appearance, Ekman and Friesen (1982a) suggested several morphological and dynamic markers (see also Frank, Ekman, & Friesen, 1993). One of the most replicated and best-documented criteria for this differentiation is the Duchenne marker (Frank & Ekman, 1993). In addition to the *zygomaticus major* muscle which produces the smiling mouth (AU12), it involves a second muscle called the *orbicularis oculi, pars lateralis* muscle. This latter muscle causes a lifting of the cheeks, narrowing of the eye-opening and wrinkles around the eye socket that are colloquially known as crow's feet. The activation of this muscle is scored in FACS as AU6 and together with AU12 it is labelled the "Duchenne smile" (in honour of Duchenne's original observations; Ekman et al., 1990). To date, much research on smiling has focused on this morphological smile-marker and its purported link to positive emotion (for an overview, see Ekman, 1992c). Being easy to detect in static displays of facial expressions, it has been proposed to be the most reliable and diagnostic marker of enjoyment smiles (Frank & Ekman, 1993).

Comparatively speaking, very little research has focused on the significance of dynamic aspects of smiles in differentiating between felt and false smiles. According to Ekman and Friesen (1982a), felt smiles are characterised by timing between 500 and 4000 ms, as opposed to false smiles that can be shorter or longer. Moreover, the dynamic nature of onset, apex, and offset phases should differ significantly in these two types of smiles. Onset refers to the length of time from the start of the smile until its maximum intensity, apex to the length of time before this peak intensity starts to decrease, and offset to the length of time from the end of the apex until the smile disappears (see Ekman et al., 2002). Ekman and Friesen (1982a) claimed that the onset time in false smiles would usually be too short, giving an abrupt appearance to the smile. The apex duration, however, would be too long, and the offset-timing would not be smooth, but would instead be abrupt.

It is evident that these dynamic markers cannot be studied in static displays of facial expressions. Measures of timing therefore are much more costly to make than the measurement of which muscles are recruited (Ekman, 1989). Probably as a result, only a few studies have examined differences between spontaneous felt and posed false smiles with respect to their dynamic properties.

Dynamic Aspects of Felt and False Smiles

One of earliest studies to provide evidence concerning some of the dynamic differences between posed smiles and smiles reflecting underlying positive affect was conducted by Weiss, Blum, and Gleberman (1987). They investigated dynamic aspects of expressions that were either posed or elicited by hypnotically induced affect. Using this technique, they found that participants who were hypnotised to experience pleasure in reaction to an emotion cue showed smiles with longer and smoother onset actions as compared to when they were simulating pleasure. Although these results were consistent with Ekman and Friesen's (1982a) original notion, the generalisability of the findings was restricted due to the sample size of just three participants.

Using a larger sample, Bugental (1986) investigated dynamic aspects of adults' smiles that were shown in reaction to responsive and unresponsive children. She found that more smiles with abrupt offsets were shown to unresponsive compared to responsive children in public settings. Moreover, adults who attributed their success as caregivers to luck rather than ability showed smiles that were faster in onset speed. Such rapidly appearing and quickly fading smiles were interpreted as a sign of managed affect. Unfortunately, no self-report measures were obtained, making it difficult to draw a firm conclusion about the adults' experienced affects.

In a more recent study, Hess and Kleck (1990) explored the dynamics of spontaneous and posed expressions of happiness and disgust that were selected on the basis of self-report data. Participants viewed emotion inducing videos while either not attempting to inhibit their facial reactions (spontaneous condition) or attempting to deceive another person about their actual emotional state (posed condition). They found that the duration and smoothness of dynamic parameters differed significantly in these two types of expression condition. Specifically, onset and offset times were significantly shorter for posed expressions (i.e., intentionally employed positive expressions to mask disgust) as compared to emotion-elicited expressions of felt joy. Moreover, posed smiles showed a higher degree of irregularity, with pauses and stepwise intensity changes, and were considerably longer in overall duration than smiles that occurred spontaneously.

A similar pattern of results was reported by Schmidt and colleagues (Schmidt, Ambadar, Cohn & Reed, 2006) who used both manual coding (FACS) and automated facial image analysis (AFIA) to investigate dynamic differences between these two smile types. In their study, all smiles came from an image database (Cohn-Kanade database) and were either deliberately posed or spontaneously occurring during a directed facial action task. Although spontaneous smiles were not based on self-report data, the presence and absence of such smiles was determined by a certified FACS coder, based on the occurrence of AU12 outside of instructed periods. The authors were able to show that onset and offset speeds were significantly faster for deliberate compared to spontaneous smiles. Interestingly, deliberate smiles were also larger in amplitude, which can be interpreted as higher intensity in this context. When controlling for amplitude as a covariate, the effect of smile type on offset speed disappeared, but it remained significant for onset speed and even became significant for onset duration (with shorter onset times for deliberate than spontaneous smiles). Thus, the type of smile was found to influence onset speed and duration over and above what was attributable to amplitude difference.

Further studies using AFIA found consistent relationships between maximum speed and amplitude in spontaneous, but not in deliberate smiles (Cohn & Schmidt, 2003; see also Cohn & Schmidt, 2004). Specifically, the temporal patterning of movement was shown to be highly consistent for spontaneously occurring smile onsets, despite individual and contextual (social, solitary) variation in smile displays (Schmidt, Cohn, & Tian, 2003). This consistency in onset could be seen as reflecting automatic pre-programmed motor routines in the case of spontaneous smiles. Facial electromyography (EMG) may provide a subtle and quantitative index of the neural activation of these underlying muscle action potentials. Hess and colleagues (Hess, Kappas, McHugo, Kleck, & Lanzetta, 1989) found that EMG variables describing the temporal characteristics of facial movements (i.e., smiling), such as time variance and time kurtosis, significantly contributed to the differentiation between posed and spontaneous smiles. Facial electromyography may therefore provide information about the activation and timing of underlying motor programmes that is relevant for smile classification (see also Frank & Ekman, 1993; Rinn, 1991).

In summary, the literature suggests that dynamic properties of smiles represent important markers for distinguishing between spontaneous and posed smiles. In several studies, smiles that were deliberately posed in the absence of positive affect differed from those produced spontaneously in terms of dynamic aspects such as smoothness and duration. In particular, the onset and offset durations were significantly shorter in posed smiles, with movement patterns that were not smooth, but rather irregular and abrupt. Using automatic facial analysis and electromyography, such posed smiles were also shown to be larger in amplitude, less consistent in their temporal characteristics, and of different nature in their EMG time domain (i.e., in kurtosis, skewness, mean, variance) than spontaneous smiles.

Perception of Smile Dynamics

There is good evidence that dynamic properties differ between smile expressions that are deliberately posed and spontaneously occurring. To decode the meaning of a particular smile, dynamic cues should therefore be detected and decoded accurately by observers. However, this may not always be the case. Hess et al. (1989) found that the EMG parameters describing the temporal aspects of facial action in posed and spontaneous smiles were not correlated with observers' ratings of how happy the sender was. Similarly, Hess and Kleck (1994) showed that for stimuli taken from their earlier study (Hess & Kleck, 1990) speed of onset did not influence accuracy of smile discrimination or judgements of control when these smiles were shown to observers. Thus, dynamic markers of a sender's affective state may not be accurately perceived by a receiver.

On the other hand, attributions made by perceivers may be based on cues that are believed to, but in fact do not, differentiate between different sender states. Hess and Kleck (1994) found that crow's feet wrinkles (one of several distinct features of Duchenne smiles) and gaze aversion significantly influenced perceived degree of control of expression, but were not related to elicitation condition. Observers were able to accurately report the cues they used in the task; however, these cues were not valid discriminators of posed and spontaneous expressions. In fact, Hess and Kleck (1994) reported that judges were relatively poor at identifying spontaneous and posed expressions. This low discrimination accuracy was found to be the result of the consistent use of invalid cues.

These findings suggest that the relationship between the encoding process and the attribution process involved in the decoding of an affective state is not always straightforward (Hess et al., 1989). Thus a distinction needs to be drawn between sender and receiver processes when studying the communicative function of dynamic cues. The Brunswikian lens model (Brunswik, 1956, as cited in Funder, 1995; see also Hess et al., 1989; Kappas, 1997) has been proved to be useful is making such a distinction. It allows researchers to treat separately the cues that are encoded by a sender and the cues that are perceived by a receiver.

In the research reported by Hess and colleagues, there are several reasons why encoder cues were not consistently used in the decoding process. In the Hess et al. (1989) study, facial EMG was employed to detect subtle differences in the time course of facial actions, such as time variance and time kurtosis. Clearly, electromyographic measures are excellent tools for studying fine grained affective responses. These subtle processes, however, are not necessarily apparent in overt facial expressions (see Cacioppo, Petty, Losch, & Kim, 1986). Differences in the time course of the facial actions therefore may have been too subtle or fleeting in order to be observable under normal viewing conditions. In this sense, it may not be the observer who lacked sensitivity or attention to dynamic cues, but rather the cues may not have been salient enough to be perceptible.

In Hess and Kleck's (1994) study, nonverbal cues emitted in spontaneous and posed expressions were combined across happiness and disgust. Although these two emotions may share common cues that enable the classification of smile types, these cannot be assumed to be identical. For example, the appearance of crow's feet wrinkles is supposed to be a distinct marker of spontaneous happiness (smiling eyes) (Ekman & Friesen, 1982a), but it has not been argued that they are of equivalent importance in the encoding of disgust. Similarly, onset speed may imply a different affective quality when seen in the context of happy expressions rather than disgust expressions. This may be the case regardless of whether the expression is spontaneous or posed. The salience of these nonverbal cues therefore may have varied as a function not only of elicitation condition, but also of emotional valence. That is, different cues may have been differently related to expressions of disgust and happiness when seen under spontaneous and deliberate conditions.

It is worth noting that Bugental (1986) also investigated the encoding and decoding of dynamic cues in smiles and found a consistent relation for some of the dependent variables. She examined whether the timing (onsets or offsets) of adult smiles influenced children's subsequent behaviour. It was found that children responded to onset and offset times and did so in a similar fashion. Specifically, they became increasingly verbally responsive to adults who produced smiles that had long onset and offset times. These effects reached significance for responsive children only. As was mentioned earlier, no self-report measures were obtained in this research, making it difficult to draw any conclusions about how these slow onset and offset smiles were perceived by children.

In sum, studies combining the expression and perception sides of the communication process have suggested that the role of dynamic properties and their function as communicative acts in expression perception may not always be straightforward. However, these studies suffered from methodological problems such as a) the derivation of time parameters from electromyographic measures that may be too subtle to be visually perceptible; b) the generalisation of dynamic parameters of spontaneous and posed expressions across differently valenced emotions (happiness, disgust); and c) the absence of self-report or judgemental data on part of the sender and perceiver. As a result, the role played by dynamic aspects of smiles in how they are perceived by others is not entirely clear.

Previous research (Ambadar et al., 2005; Kamachi et al., 2001; Lander et al., 1999; Pike et al., 1997) has demonstrated that facial dynamics provide important information for emotion and identity recognition. By viewing dynamic displays, different emotions and faces could be accurately identified and differentiated from each other. Facial motion was also shown to influence ratings of intensity and realism (Biele & Grabowska, 2006; Weyers et al., 2006) and naturalness of expressions (Sato & Yoshikawa, 2004). Interestingly, the impact of dynamic aspects on evaluations of the truthfulness or deceitfulness of an emotional display (e.g., a smile) has not been addressed. Such an approach is different from naturalness and realism ratings, which are mainly concerned with whether an expression appears plausible rather than whether it is a plausible but fake expression.

In our own research (Krumhuber & Kappas, 2005), we therefore wanted to investigate whether dynamic aspects influence how genuine smile expressions are perceived to be as signs of felt enjoyment. If facial dynamics provide information to an observer concerning the affective state of the sender, we expected that the onset, apex and offset durations of smiles would significantly influence ratings of the degree of smile genuineness. For this purpose, dynamic smile expression sequences varying in their onset, apex, or offset durations were created using a computer graphics tool (Poser 4, Curious Labs). By switching to facial synthesis, we were able to systematically vary the dynamic variables within the range of several milliseconds while keeping morphological parameters constant. Duration parameters for onset, apex and offset phases were derived from previous encoding studies (Schmidt & Cohn, 2001; Cohn & Schmidt, 2003) and based on informal pre-tests. In three experiments, each addressing a specific component (onset, apex, or offset) alone or in combination, we found that dynamic aspects significantly influenced judgements regarding the authenticity of the smile expression. Specifically, smiles with longer onset and offset durations were rated as more genuine than their shorter counterparts, whereas authenticity ratings decreased as a function of how long the smile was held at the apex.

In a second study (Krumhuber et al., 2007), we found that facial dynamics significantly influenced not only the perception of the smile expression, but also how the person expressing the smile was perceived. Smile expressions were operationalised here by either long or short onset durations (based on our preceding study) and shown in combination with three forms of head-tilt that were generated using the same graphics animation software. It was found that stimulus persons who displayed smiles with long onset durations were perceived as more trustworthy, more attractive, and less dominant. Smiles with long onset durations were also judged to be more flirtatious and less fake than those with short onset durations. The effect of smile dynamic was further found to be moderated by head-tilt, gender of encoder and perceiver. Thus, the perceived meaning of dynamic smile expressions was not fixed, but rather was dependent to some extent on the effects of other variables.

Together these findings provide supportive evidence that dynamic aspects contain important information concerning the underlying truthfulness and authenticity of an expression, and are decoded by observers who are asked to make judgements about smile displays. Perceivers are sensitive to the dynamic qualities of smile expressions and take these into account when making inferences about the personal dispositions of the person who smiles. A smile therefore does not have a single meaning for an observer. Different dynamic forms of smiles give rise to different judgements of expression and of expresser.

Unanswered Questions

The two studies just described indicate that useful information is extracted from the dynamic aspects of facial expressions that influence not only expression perception, but also person perception. Nonetheless, there are several questions that still need to be addressed.

First, in our previous research we explored the effects of facial dynamics in synthetic faces that were made with Poser 4 graphics software. The artificiality of such faces raises the question of whether these findings would generalise to real human faces. Facial dynamics may be interpreted differently depending on whether they occur in a synthetic face or a realistic human face. The same facial actions may lead to different judgements, depending on the type of stimulus. A key question is therefore whether dynamic aspects of smile expressions have the same impact on perceptions of expressions and expressers in human-like faces as they do in synthetic faces.

Second, in previous research we investigated the effects of facial dynamics in Duchenne smiles only. That is, onset, apex and/or offset durations were systematically varied in smile expressions that featured the Duchenne marker (AU6+12). Given that the Duchenne smile has itself been proposed as a marker of felt smiles, it would be interesting to examine whether facial dynamics shape people's perceptions independently of the presence of the Duchenne marker. If dynamic properties are sufficient markers of authenticity, judgements should vary regardless of whether or not the smile involves the Duchenne marker.

Third, in our past research we simply asked participants to indicate their perceptions of the smiling person and the expression without giving them any contextual information. In this sense, participants were required to form their impressions independently of any situational background. In everyday life such isolated perceptions are rare. It remains to be seen whether similar findings would be obtained in concrete situations in which a social context is provided. If this is indeed the case, this would be evidence of the general impact of facial dynamics on expression and person perception, even under circumstances where there is limited opportunity to form impressions.

Fourth, we have so far shown the effects of facial dynamics on interpersonal perceptions and judgements of the expression, but not on potentially more consequential measures such as intentions and decisions. That is, are perceivers' decisions affected by the temporal characteristics of an individual's facial expressions? And does the temporal quality of smiles shape the perceiver's behavioural intentions with respect to the expresser? An important step is therefore to determine whether facial dynamics also help to shape consequential decisions.

Fifth, in our previous research we did not test the impact of facial dynamics in real smiles that were either spontaneously made or posed. A common claim in the literature is that the Duchenne marker is the most reliable feature – more diagnostic than dynamic markers –

in distinguishing between these two smile types. Interestingly, no research has systematically tested how reliable and valid this morphological marker actually is. Moreover, the predictive value of the Duchenne smile alongside other dynamic and behavioural markers in accounting for perceivers' ratings still needs to be researched. A crucial question therefore concerns the reliability of this Duchenne marker in differentiating between spontaneous and posed smiles, and whether this distinction is disrupted when perceivers have access to static but not dynamic information.

Sixth, until now we have focused only on nonverbal cues such as facial dynamics and their effect on receivers. However, nonverbal communicative acts do not typically occur in isolation. Most of our everyday communication involves the integration of verbal and nonverbal information. A further issue to be addressed concerns the effects of dynamic aspects of smile expressions in combination with speech. The whole meaning of a message may change depending on what is conveyed in the face and through speech. Furthermore, the facial and verbal channels may not combine in a consistent way, but rather convey contradictory information. It therefore needs to be assessed whether the impact of smile expressions with different temporal characteristics varies when they are combined with verbal messages that are either consistent or inconsistent with the expression, in terms of emotional quality. In other words, are perceivers equally sensitive to the connotations of a fast (versus slow) onset smile when it is combined with an angry (versus happy) utterance?

Overview of the Present Dissertation

The aim of the present dissertation is to address the aforementioned questions and thereby to achieve a better understanding of the communicative value of temporal dynamics in facial displays. Of all facial expressions, the smile is the one that is probably the most elusive to explain, and the most difficult to understand (Abel, 2002). This dissertation will therefore focus on the role played by dynamic aspects in smile expressions. In the following four chapters, nine experimental studies are reported that address one or more of the six key questions outlined above.

Chapters 2 and 3 report studies using two specific social settings and examining whether smile dynamics – independent of the Duchenne marker – influence people's behavioural intentions and decisions. In Chapter 2, a simulated job interview situation is used and the impact of interviewees' smiles is investigated with respect to interview impressions and subsequent employment decisions. The nature of this setting makes it suitable to test this effect in the context of relatively 'thin-slice' displays of expressive behaviour, i.e., expressive information that is available for a short period of time. Furthermore, I examine whether facial dynamics lead to similar impression effects and decisions ratings when shown in synthetic faces compared to real human faces.

In Chapter 3, two trust game scenarios are employed. Participants can either choose (from three possibilities) with whom to play the game, or they are assigned a counterpart. The games involve financial stakes. Here the impact of dynamic aspects of smiles is investigated on participants' choices of counterpart and their decisions about whether or not to cooperate. In addition, I explore whether such intentions to cooperate are mediated by inferences of the opponent's trustworthiness, as influenced by facial dynamics.

Chapter 4 focuses on real occurring smiles that are either spontaneously made or posed and investigates whether the presence or absence of the Duchenne marker is a reliable way of discriminating between these two smile types on the expresser's side. I further explore whether perceivers' ratings of degree of smile genuineness and amusement distinguish between Duchenne smiles accompanied by high versus moderate positive emotion, when having access to the upper or lower face only, and when seeing dynamic compared to static images of the face. Putting together the encoding and decoding aspects of the communication process, the predictive value of the Duchenne marker is examined alongside other dynamic and behavioural markers in accounting for perceivers' ratings.

Chapter 5 explores the effects of smile expressions that have different temporal qualities in combination with verbal utterances and examines whether and how these two communication channels interact in shaping observers' perceptions. Specifically, I examine how smile expressions affect the interpretation of verbal messages that are either consistent or inconsistent with the facial information. I also explore whether perceivers' judgements significantly vary as a function of the dynamic properties of the smile expression. Moreover, the perceived function of smiles as signs of happiness is investigated in verbal messages that convey different negative emotions.

Finally, in Chapter 6 I summarise the findings reported in Chapters 2 to 5 and integrate them into a framework that aims to provide a more complete picture of the role played by dynamic aspects of facial expressions. The contributions and limitations of the research reported in the present dissertation are also discussed, and several avenues for future research are identified.

CHAPTER 2

Effects of Dynamic Attributes of Smiles in Human and Synthetic Faces: A Simulated Job Interview Setting

Many decisions in human life are based on limited information available for a short period of time. There is often no or minimal knowledge of other persons we encounter and as a result first impressions are determined by any available cues (Forgas, 1985). Furthermore, some of these decisions do not take place in the real world, but are made in virtual environments such as the worldwide web. In such contexts, the interface with which we are communicating increasingly consists of virtual humans who exhibit various types of life-like behaviour (see Blascovich, 2001; Dehn & van Mulken, 2000). Whether others are synthetic or real, we are often faced with minimal information about them and in consequence have to rely on brief observations of their behaviour (see Ambady, Bernieri, & Richeson, 2000; Ambady & Rosenthal, 1992, 1993). In the present research we examine the impact of facial information on social perceptions and decisions made on the basis of short segments of expressive behaviour. Moreover, we investigate whether similar judgements are made in response to synthetic and real human faces.

In recent years, there has been a growing interest in making animated characters depicted in film and online games (see Kerlow, 2004) and human–computer interaction (see Blascovich, 2001; Dehn & van Mulken, 2000) more human-like, with photorealistic faces (Takács & Kiss, 2003). A goal in computer graphics is to develop these computer-generated humans in such a way that they are capable of expressing fine shades of emotions. Although previous research has investigated general evaluations of animated figures such as embodied interface agents (Blens, Krämer, & Bente, 2003; Koda & Maes, 1996; Wiberg & Wiberg, 2001; see Dehn & van Mulken, 2000, for a review), the effects of specific nonverbal behaviours when exhibited by virtual characters have rarely been studied in detail (for gestural activity, see Krämer, Tietz, & Bente, 2003; for gaze behaviour, see Bailenson, Blascovich, Beall, & Loomis, 2001). Moreover, researchers have not explored whether these nonverbal actions (e.g., facial expressions) are interpreted in the same way when seen in synthetic cartoon faces or more realistic human faces. Thus, the same facial actions could lead to different judgements and decisions, depending on the type of stimulus. Although Bente, Krämer, Petersen, and de Ruiter (2001) compared original video recordings of two interacting people with recordings of computer animations, their study pertained to whole body movements rather than facial behaviour in particular. In the present research, we investigated the perception of different temporal forms of smiles in synthetic faces and explored whether the findings obtained with these stimuli are paralleled when the stimuli are real human faces.

The smile is a particularly relevant expression to study because it not only occurs in conjunction with a positive affect, but can also be faked to convince another that enjoyment is occurring when it is not (Ekman, 1985; Ekman & Friesen, 1982a; Ekman, Friesen, & O'Sullivan, 1988). A distinction therefore needs to be drawn between genuinely happy smiles and fake or false smiles. Several morphological and temporal differences between these two types of smile have been noted (Ekman, Davidson, & Friesen, 1990), but most past research has focused on the Duchenne marker (with its morphological features of raised cheeks, bulges around the eyes, crow's feet wrinkles) and its role in smile differentiation (see Ekman, 1992c). However, the temporal feature of smiles also provides a potentially important way of distinguishing between smile types (see Ekman & Friesen, 1982a).

Several studies have shown that genuine smiles differ from false ones in their temporal parameters. Specifically, longer onset and/or offset durations were found for spontaneous felt smiles than for posed or false ones (Bugental, 1986; Hess & Kleck, 1990; Schmidt et al., 2006; Weiss et al., 1987). Temporal dynamics of moving displays have also been shown to have a beneficial effect on the recognition of personal identity in humans (e.g., Bassili, 1978; Bruce & Valentine, 1988; Lander et al., 1999), and the identification or discrimination of emotional expressions (Ambadar et al., 2005; Bassili, 1979; Bould & Morris, in press; Kamachi et al., 2001; Wehrle et al., 2000). An under-researched issue is the role played by temporal features in emotion interpretation. While Sato and Yoshikawa (2004) explored the effects of different presentation velocities on the perceived artificiality of morphed expressions, their study related more to the plausibility, rather than the perceived genuineness of facial displays.

In previous work we therefore investigated whether temporal dynamics influenced the interpretation of smile expressions, particularly with respect to their rated truthfulness. Using synthetic facial stimuli, we showed that variations in temporal parameters influenced trait judgements and perceptions of smile authenticity. Specifically, smiles with longer onset and offset durations were judged as more authentic than their shorter counterparts, whereas genuineness ratings decreased as a function of how long the smile was held at the apex (Krumhuber & Kappas, 2005). Furthermore, stimulus persons who displayed smiles with long onset durations were rated as more trustworthy, more attractive, and less dominant (Krumhuber et al., 2007).

A question that has not yet been addressed concerns the impact of dynamic properties of smiles on decision making. To what extent are perceivers' decisions affected by the temporal characteristics of facial expressions? And does the temporal quality of smiles shape the behavioural intentions of raters? Especially when perceivers have little information available subtle expressive cues may be influential. In the present research we used a simulated job interview situation to examine whether temporal parameters of smiling shape interview impressions and employment decisions and have a similar effect in synthetic and human faces. Although synthetic stimuli may lack realism, there is evidence that people treat virtual characters as if they were actual humans (Bailenson et al., 2001). Moreover, recent business analyses suggest that more and more companies rely on simulated job situations involving virtual humans to train their staff (BusinessWeek, 2006). The job interview situation as used in this research may therefore share some commonalities with those simulation/training games. This allows for an environment in which it becomes increasingly natural to interact with synthetic, artificial characters.

There is considerable evidence that nonverbal behaviour (i.e., eye contact, gesturing, and smiling) plays an important role in influencing interview impressions and hiring decisions (Edinger & Patterson, 1983; Imada & Hakel, 1977; Young, & Beier, 1977). Specifically, job applicants who displayed higher levels of smiling were found to be evaluated more favorably and their chances of being hired were increased. Forbes and Jackson (1980) showed that 'accept' interviews were characterized by more smiling, whereas more neutral facial expressions appeared in 'reject' interviews. The impact of different forms (i.e., temporal) of smiles on hiring decisions has not yet been investigated. This seems relevant given that smile expressions in job interview settings are often likely to be voluntarily produced for impression management purposes (see DePaulo, 1992). Given the varying meanings of smiles (see Ekman, 1985) such managed expressions need to be distinguished from authentic smiles which spontaneously occur in conjunction with felt positive emotions (Ekman & Friesen, 1982a).

Participants were shown short excerpts from a simulated job interview in which each of three interviewees responded to a mildly amusing utterance made by the interviewer. We expected that the temporal form of interviewee's smiles in reaction to this remark would provide important information to observers about the genuineness of the expression. Specifically, we hypothesized that dynamic authentic smiles would be perceived as more immediate and genuine, leading to more favorable ratings of the interviewee (i.e., friendly, warm, kind) and of her job related attributes (i.e., reliable, trustworthy, involved). Such immediacy (see Imada & Hakel, 1977) would be absent in dynamic fake smiles, which are put on to make it appear that positive feelings are experienced when in fact nothing much is felt (i.e., phoney smiles, Ekman & Friesen, 1982a). Interviewees displaying authentic smiles should therefore be rated higher on expression, person and job attributes than falsely smiling or non-expressive interviewees. Furthermore, they should receive more favorable hiring evaluations and be considered more suitable for the job.

Experiment 2.1

The first study addressed the impact of temporal aspects of facial displays on interview impressions and decisions in synthetic faces. Thin-slice samples of a simulated job interview situation were employed in which interviewees displayed authentic smiles, fake smiles, or neutral expressions.

Method

Participants

Seventy-two participants (36 males, 36 females), aged 18 to 39 years ($M = 22.89$) at Cardiff University, UK took part individually either for course credit or for a payment of £3.00.

Stimulus Material

The stimulus material consisted of brief (30 s) video excerpts depicting a job interview situation. Each excerpt was accompanied by the same audio recording in which the interviewer was heard making some general remarks about the nature of the job for which the candidate seen in the video had supposedly applied. In the course of these remarks he made a mildly amusing utterance, thereby providing an occasion for the interviewee to smile. Each participant viewed three video excerpts, each with a different interviewee: one in which the interviewee displayed an authentic smile, one in which the interviewee displayed a fake smile; and one in which the interviewee remained neutral. The sequence of facial expressions was counterbalanced across interviewees.

Facial stimuli consisted of synthetic faces generated using Poser 4 (Curious Labs, Santa Cruz, CA) animation software. The three female faces chosen for this experiment were matched for attractiveness (M = 5.15, scale 1-7) and trustworthiness (M = 4.98), as determined in a pilot study (N = 16). For each Poser face, a neutral expression and two dynamic smile expressions differing in onset, apex, and offset durations were synthesised at a frame rate of 30 images per second. Smiles with long onset (16 frames) and offset (64 frames) durations and a relatively short apex (40 frames) duration were classified as authentic smiles. Fake smiles were characterised by short onset (4 frames) and offset (5 frames) durations and a long apex (111 frames) duration. These parameters were derived from a previous study (Krumhuber & Kappas, 2005), in which it was found that the perceived genuineness of smiles increased as a function of onset and offset durations, and decreased as a function of apex duration. The smile expression was operationally defined as an upper smile (lip corner pull, AU 12, Facial Action Coding System; Ekman & Friesen, 1978) with mouth opening (AU 25), and set at a medium intensity of 0.8 (see Figure 2.1 for examples of neutral and smile expressions).

Figure 2.1. Three Poser female characters with a neutral expression (top) and an open-mouth smile (bottom).

Because we aimed to study the effects of the temporal dynamics independently of the influence of morphological factors, such as the "Duchenne marker" (i.e., orbicularis oculi activity, AU 6), only the mouth region was animated. To create realistic looking smiles that would be natural in their appearance, we therefore chose a medium level of smile intensity. This allowed us to examine the impact of smile dynamics independently of the influence of AU 6. All smiles lasted 120 frames (i.e., 4 seconds). The three Poser models showing three different facial expressions were rendered in color with the same viewpoint, camera focal length and lighting. The resulting images measured 411 x 491 pixels each and were shown in random order as movie-clips in Medialab (Empirisoft).

Procedure

Participants arrived individually at the laboratory and were seated at a table with a computer workstation. After signing a consent form, they were instructed that they would view three short video excerpts depicting a job interview situation. They were told that in each excerpt a head and shoulders shot of the interviewee would be visible as he or she listened to the interviewer. Participants were told that the interviewer would follow the same script because the interview was intended to be a standard situation for all interviewees. After answering any of the participants' remaining questions regarding the procedure, the experimenter left the room. The video sequences could be initiated by using the mouse to click a 'Start' button on the computer screen. After each sequence, participants were instructed to respond to several judgement scales. The next video sequence was started by clicking a 'Continue' button on the screen.

Dependent Variables

Participants rated each video excerpt with respect to how *kind*, *sociable*, *attractive*, *likeable*, *warm* and *friendly* they perceived the interviewee to be, and how *formal*, *tense*, *flirtatious*, *genuine*, *polite*, *charming*, *spontaneous*, and *seductive* they perceived the interviewee's expression to be. Interviewees were also evaluated on six dimensions that had been rated in a pilot study (N = 17) as important for job applicants in any field: *competent*, *motivated*, *trustworthy*, *involved*, *interested*, and *reliable*. These 20 adjectives were presented in random order. Participants were asked to respond by clicking a mouse on the appropriate points of a 7-point Likert scale with response options ranging from 1 (*not at all*) to 7 (*very*). After the final adjective, participants were asked to judge a) how suitable the person was for the job (1 = *not suitable at all*, 7 = *very suitable*), b) how likely it was that this person would be short-listed for further interview (1 = *not likely at all*, 7 = *very likely*), and c) how likely it was that this person would be selected for the position (1 = *not likely at all*, 7 = *very likely*). For each employment decision, participants were also asked to indicate how confident they were about the judgement they had just made (on a 7-point scale, 1 = *not confident at all*, 7 = *very confident*).

Results

Data Reduction

The 26 ratings made by participants were subjected to principal component analyses to guide scale construction. This led to the construction of four scales. Internal consistency was assessed separately for each of these scales for authentic smiles, fake smiles and neutral expressions. The first scale reflected *job* ratings (authentic: $\alpha = .92$, fake: $\alpha = .89$, neutral: $\alpha = .95$) and consisted of the items reliable, interested, involved, trustworthy, motivated, competent; suitable, short-listed, and selected (item content abbreviated). The second scale reflected *person* ratings (authentic: $\alpha = .87$, fake: $\alpha = .87$, neutral: $\alpha = .86$) and consisted of the items sociable, likeable, kind, friendly, warm, and attractive. The third scale reflected *expression* ratings (authentic: $\alpha = .75$, fake: $\alpha = .69$, neutral: $\alpha = .68$) and consisted of the items tense (reverse-coded), polite, formal (reverse-coded), charming, flirtatious, seductive, spontaneous, and genuine. Higher scores on this measure reflect greater positivity. The fourth scale reflected *confidence* ratings (authentic: $\alpha = .94$, fake: $\alpha = .91$, neutral: $\alpha = .91$) and consisted of the items confidence/suitable, confidence/short-listed, and confidence/selected (item content abbreviated).

Analysis of Variance

Preliminary analyses showed that there was no significant effect of encoder face, $F(52, 19) = 1.78$, $p > .05$. Therefore, results were collapsed across all three encoders to investigate differences as a function of facial expression. A MANOVA with repeated measures on the facial expressions factor was performed on the 4 dependent variables described above (job, person, expression, and confidence). A highly significant multivariate main effect was found for facial expression, $F(8, 63) = 11.01, p < .001$. Univariate tests showed significant main effects on job, $F(2, 140) = 11.10, p < .001$, person, $F(2, 140) = 40.70, p < .001$, and expression ratings, $F(2, 140) = 37.78, p < .001$. Means and standard errors are shown in Table 2.1 Interviewees displaying authentic smiles received significantly higher ratings and were evaluated more favorably on the job, person and expression scales than were their fake smiling or non-expressive counterparts. They were also judged to be more suitable, and more likely to be short-listed and selected for the job. Overall, the neutral expression was perceived most negatively, with low ratings on these three dependent measures.

Table 2.1

Means and Standard Errors ($N = 72$) for Four Dependent Measures as a Function of Facial Expression.

	Facial Expression					
	Authentic smile		Fake smile		Neutral expression	
Measure	*M*	*SE*	*M*	*SE*	*M*	*SE*
job	4.42_a	.11	3.91_b	.10	3.73_b	.14
person	4.42_a	.12	4.12_a	.11	3.21_b	.11
expression	3.88_a	.10	3.47_b	.10	2.80_c	.10
confidence	4.50	.18	4.25	.17	4.46	.16

Note. All ratings were made on Likert-scales from 1 to 7, with higher numbers indicating greater levels of that dimension. Row means with different subscripts differ at $p < .01$.

Polynomial contrast analyses revealed a significant linear trend for job, $F(1, 70) = 19.37, p < .001$, person, $F(1, 70) = 66.95, p < .001$, and expression, $F(1, 70) = 69.71, p < .001$, confirming that judgement ratings varied linearly as a function of the quality of facial expression. No significant effect was found for participants' confidence ratings, $F(2, 140) = 2.59, p > .05$. There was no significant main effect for the sex of perceiver variable, $F(4, 67) = 2.28, p > .05$.

Discussion

There was a strong and significant effect of facial expression on participants' impressions and employment decisions made in the context of a simulated job interview. More positive evaluations were made of interviewees who showed an authentic smile than of those exhibiting a fake smile or a neutral expression. The former were evaluated more favorably with respect to job attributes, trait adjectives and expression items. The results of this study are consistent with our previous findings (Krumhuber & Kappas, 2005; Krumhuber et al., 2007) and provide further empirical support for the notion that temporal features of facial expressions influence person and expression perception. A new finding is that the facial expressions of target persons who were allegedly being interviewed for a job affected judgement ratings of the targets' suitability for the job in question. So the temporal quality of facial expressions influences not only person perception but more consequential decisions.

Overall, the smiles with dynamic properties intended to convey genuineness were judged most favorably, followed by fake smiles and neutral expressions. This linear trend shows that some form of positive facial behaviour (even it seen as fake) is better than remaining neutral, even in the relatively formal setting of a job interview, which seems to reflect the power of the norm that one should smile during social interaction.

The stimulus material in this study consisted of synthetic faces. Given that synthetic faces differ from real ones on a range of attributes, it remains to be shown whether the results actually generalise to real people. This was the aim of a second experiment in which we studied the effects of temporal variations in smiles in realistic human faces.

Experiment 2.2

Stimulus persons in the second experiment were real persons who were videotaped and whose expressions were manipulated using computer generation techniques. The experimental setting and procedures were exactly the same as those used in Study 2.1. Thus, interviewees showed authentic smiles, fake smiles or neutral expressions and were judged on the same set of attributes as those used in the first study.

Method

Participants

Seventy-two participants (36 males, 36 females), aged 18 to 38 years ($M = 22.89$) took part in this study. They were all students at Cardiff University, UK, and they were given either course credit or payment of £3.00.

Stimulus Material

The video excerpts were similar to those in Study 2.1, including the same audio script. Participants were shown 3 short excerpts (30 s) from a job interview in which one of 3 interviewees reacted with a neutral expression, a fake smile or an authentic smile to a mildly amusing utterance made by the interviewer. The sequence of facial expressions was counterbalanced across interviewees.

Facial stimuli consisted of real faces that were subjected to computer animation. The three female characters chosen for this experiment were matched on attractiveness (*M* = 5.57, scale 1-7) and trustworthiness (*M* = 4.56), as determined in a pilot study (N = 16). To construct dynamic smile expressions with standardised timing parameters, a smile synthesis model was built on each face. The smile model was restricted to the lower face and was shown against a neutral background movie of the person. In this sense, only the mouth region was animated (lip corner pull, AU 12), thereby allowing the study of the sole influence of the smile dynamics independently of orbicularis oculi activity (AU 6).

For animation, smile parameters were extracted from the original videos of the females by setting landmarks around the mouth, jaw and the corner of the eyes. Using the mouth landmarks, an appearance model of the mouth could be constructed. The resulting appearance parameter then represented a smile as a measure of texture variation, where a full smile represented a maximum change in texture variation with respect to a neutral mouth. Varying the onset, apex, and offset durations of this parameter equated to reordering lower face textures from the original video. This resulted in the creation of smiles with the same temporal properties as in Study 2.1. The smile expression was operationally defined as an upper smile (lip corner pull, AU 12) with mouth opening (AU 25) and synthesised at a medium level of intensity (see Figure 2.2 for examples of neutral and smile expressions). All smile stimuli lasted 120 frames (i.e., 4 seconds). The three female characters showing three different facial expressions were displayed in random order as movie-clips (504 x 403 pixels) in Medialab (Empirisoft).

Figure 2.2. Three human female characters with a neutral expression (top) and an open-mouth smile (bottom).

Procedure and Dependent Variables

These were the same as in Study 2.1.

Results

Data Reduction

Principal components analyses were performed on the 26 items to guide scale construction. As in Experiment 2.1, items were grouped into four scales that had good internal consistency in each expression condition. The scales were interpreted as *job* (reliable, interested, involved, trustworthy, motivated, competent; suitable, short-listed and selected; authentic: α = .95, fake: α = .95, neutral: α = .93), *person* (reliable, interested, involved, trustworthy, motivated, competent; suitable, short-listed, selected; authentic: α = .86, fake: α = .89, neutral: α = .86), *expression* (tense [reverse-coded], polite, formal [reverse-coded], charming, flirtatious, seductive, spontaneous, genuine; authentic: α = .65, fake: α = .73, neutral: $\alpha = .65$) and *confidence* (confidence/suitable, confidence/short-listed, confidence/selected; authentic: $\alpha = .92$, fake: $\alpha = .92$, neutral: $\alpha = .90$).

Analysis of Variance

Preliminary analyses showed that there was no main effect of encoder face, $F(52, 19) = 1.85$, $p > .05$. Results were therefore collapsed across all encoders. A MANOVA with repeated measures (on the facial expression factor) was preformed on the job, person, expression, and confidence ratings. As in Experiment 2.1, there was a significant multivariate main effect of facial expression, $F(8, 63) = 21.32$, $p < .001$. Univariate tests showed significant main effects on all four dependent measures: job, $F(2, 140) = 19.49$, $p < .001$; person, $F(2, 140) = 42.35$, $p < .001$; expression, $F(2, 140) = 37.55$, $p < .001$; and confidence, $F(2, 140) = 4.07$, $p < .05$. Means and standard errors are shown in Table 2.2.

Interviewees displaying authentic smiles attracted more favorable ratings with respect to job, person and expression attributes than did their fake smiling or non-expressive counterparts. They were also judged to be more suitable for the job, and more likely to be short-listed and selected. Interestingly, participants were more confident in their judgements of interviewees who showed a fake smile than they were in their judgements of interviewees displaying a neutral expression. Polynomial contrast analyses showed that there was a significant linear trend for job, $F(1, 70) = 26.44$, $p < .001$, person, $F(1, 70) = 105.49$, $p < .001$, and expression, $F(1, 70) = 78.65$, $p < .001$. A quadratic trend emerged for confidence, $F(1, 70) = 6.98$, $p < .05$, and was also found to be significant for job, $F(1, 70) = 11.88$, $p < .01$. No significant main effect was found for sex of perceiver, $F(4, 67) = 1.28$, $p > .05$.

Table 2.2

Means and Standard Errors ($N = 72$) for Four Dependent Measures as a Function of Facial Expression.

	Facial Expression					
	Authentic smile		Fake smile		Neutral expression	
Measure	*M*	*SE*	*M*	*SE*	*M*	*SE*
job	4.03_a	.13	3.06_b	.14	3.11_b	.13
person	4.36_a	.11	3.44_b	14	2.93_c	.11
expression	3.82_a	.10	2.84_b	.13	2.59_b	.10
confidence	4.70_{ab}	.18	4.97_a	.18	4.68_{bc}	.17

Note. All ratings were made on Likert-scales from 1 to 7, with higher numbers indicating greater levels of that dimension. Row means not sharing a common subscript differ at $p < .05$.

Discussion

The results are very similar to those found in Study 2.1. The temporal quality of interviewees' facial expressions had a significant impact on both impression ratings and subsequent decisions. In the context of a simulated job interview, participants made more positive evaluations of interviewees displaying authentic smiles than of those exhibiting fake smiles or neutral expressions. In addition, authentic smiles resulted in more favorable hiring evaluations and employment decisions. The significant linear trend found in Study 2.1 for job, person and expression ratings was replicated here, with authentic smiles judged as most positive, followed by fake smiles and neutral expressions. Again, neutral expressions attracted the lowest ratings. An interesting finding which we did not find in the previous study was that confidence ratings were also significantly influenced by facial expression. Participants were more confident about their hiring evaluations when judging fake smiling interviewees as compared with neutral ones.

General Discussion

The goal of the current research was to investigate the impact of varying the temporal parameters of smiles on impressions and decisions made in a simulated job interview context. We also examined whether similar findings would be obtained in response to synthetic faces and human faces. Participants saw either synthetic (Study 2.1) or human (Study 2.2) characters who responded to a mildly amusing utterance made by the interviewer either by smiling that looked authentic or fake, or by remaining neutral. It was predicted that authentic smiles would be perceived as more spontaneous and genuine, and would attract more positive person and job ratings than would fake smiles or neutral expressions. In the context of a job interview we assumed that fake smiles in reaction to the interviewer's remark would appear phony, as being put on for impression management purposes.

The results of the two studies confirmed that temporal dynamics had an effect on job, person and expression ratings, and on employment decisions. In general, interviewees displaying dynamic authentic smiles were evaluated more favorably with respect to job attributes, trait adjectives and expression items than were those who showed fake smiles or neutral expressions. They were also judged to be more suitable and were more likely to be short-listed and selected for the job. The findings extend previous evidence on dynamic smile perception (Krumhuber & Kappas, 2005; Krumhuber et al., 2007) and show that temporal dynamics similarly influence relevant decisions and behavioural intentions. Moreover, such effects occurred for human as well as for synthetic faces.

For both types of stimulus the timing parameters of dynamic authentic and fake smiles were exactly the same and differed between conditions by only a few milliseconds. Minimal temporal changes in facial displays are therefore sufficient to influence impressions and decisions. Furthermore, this happened in the absence of smile-related activity around the eyes (the Duchenne marker). Such evidence supports the notion that temporal dynamics alone have the capacity to influence perceivers' judgements and decisions. This suggests that the temporal parameters of smiling are worthy of careful consideration, alongside the Duchenne marker, as reflections of the genuineness of smiles.

Overall, there was noteworthy correspondence between synthetic and human facial stimuli with respect to the effects of the variations in temporal parameters. This correspondence is consistent with prior research comparing these two types of stimulus with respect to impressions formed on the basis of whole body movements (Bente et al., 2001). Importantly, the present findings suggest that it is safe to generalise from findings observed using synthetic faces to the perception and judgement of human faces. This is valuable from the perspective of emotion researchers interested in using synthetic faces because of the ready way in which they can be manipulated for experimental purposes. It should also be encouraging for computer scientists who are engaged in synthesizing emotions in virtual humans (Blascovich, 2001; Cosker, Paddock, Marshall, Rosin, & Rushton, 2005; Takács & Kiss, 2003; Wallraven, Breidt, Cunningham, & Bülthoff, 2005). Although it is challenging to create emotion portrayals that are believable and convincing, the present results suggest that reasonably subtle variations in the dynamics of smiles in synthetic faces have effects on perceivers that parallel those found when similar variations are made in human faces.

The role of nonverbal behaviour in shaping the outcome of job selection interviews has been investigated by previous researchers (Edinger & Patterson, 1983; Imada & Hakel, 1977; Young & Beier, 1977). However, the effect of different temporal forms of smile on impressions and decisions in job interviews has not been explored before. The present study extends previous findings by suggesting that it is not only *what* you show on the face, but also *how* you show it that influences impressions and decisions (cf. Imada & Hakel, 1977). Putting on a smile may be advantageous by comparison with remaining neutral, which may be seen as reflecting a lack of interest or involvement. However, the *quality* of the smile also has an influence on the overall impression and subsequent decisions.

A possible limitation of the present research is the fact that only female stimulus faces were used. Future research should examine whether similar effects are also found for male faces. There is evidence of gender stereotypic effects in the perception of facial expressions (Hess, Blairy, & Kleck, 1998, 2000), and specifically smile expressions (Hess, Adams, & Kleck, 2005; Shrout & Fiske, 1981; Senecal, Hess, & Kleck, 1996, as cited in Hess, 2001). If women are expected to smile more than men in a given setting, it may be that the impact of changes in the temporal parameters of smiles would not be the same when seen in the context of a male face. Another limitation is that the present research only considered the effects of varying the temporal parameters of smile expressions. It would be interesting to establish whether changes in temporal dynamics also have an effect on perceptions of negative facial displays. Negative expressions such as anger are regarded as more appropriate in men than in women (Hess et al., 2005), so it is possible that temporal variations in facial displays of anger might lead to different judgements depending on the sex of the encoder.

A final point is that changes in smile dynamics may well interact with other nonverbal or verbal behaviour to create impressions and influence decisions in perceivers. Indeed, we know from previous research (Krumhuber et al., 2007) that the influence of smile dynamics can be moderated by head-tilt behaviour. Verbal content may compete with nonverbal behaviour in influencing interview impressions (Rasmussen, 1984; Riggio & Throckmorton, 1988). Future research could examine the relative impact of each component. It would be especially interesting to consider the effects of contradictory nonverbal and verbal information (as when an interviewee says that he or she enjoys being challenged at work while smiling in an inauthentic fashion).

The present study has demonstrated the impact of different temporal forms of female smiles on job-related impressions and decisions and has replicated these effects using synthetic and human facial stimuli. It falls to future research to examine responses to variations in the dynamics of smiles in male faces, or to variations in the dynamics of other expressions.

CHAPTER 3

Facial Dynamics as Indicators of Trustworthiness and Cooperative Behaviour[2]

In many situations we face a choice of whether to pursue our own short-term interests, or to rely on another person to maximise collective interests (De Cremer, 1999). There are potential gains if cooperation is achieved, but a risk that one might be exploited by cheaters who take advantage of one's own cooperation. It is therefore valuable to be able to spot interaction partners who are likely to be cooperative (Frank, 2004).

Trust has been shown to be an important precursor in the development of cooperation (Ross & LaCroix, 1996). We only make risky choices that render us vulnerable to others if we trust those others. When this trust is absent we are less likely to expose ourselves to risk of exploitation. But how can we tell whether or not another person can be trusted? Are there some signals that indicate trustworthiness and future cooperative behaviour?

Clearly, it would be efficient in evolutionary terms to be able to detect trustworthiness in others quickly and on the basis of nonverbal cues. There is recent evidence showing that facial appearance influences attributions of competence and might affect voting behaviour (Todorov, Mandisodza, Goren, & Hall, 2005). Such effects are, at least partly, linked to automatic attributions of trustworthiness based on the shape of the face and can occur in less than a second (Willis & Todorov, 2006).

However, the face is more than a static appearance cue with specific physical features. Facial expressions have been shown to provide behavioural and situational information in trust related contexts (Boone & Buck, 2003). They are important signals of emotional states (Ekman, 1982) and communicate our intentions to others (Keltner & Haidt, 1999). For

[2] This chapter is based on Krumhuber, Manstead, Cosker, Marshall, Rosin, & Kappas (in press).

example, someone who smiles may appear to be happy and approachable, and therefore likely to engage in cooperative behaviour. Detecting such expressions would therefore seem to be a route to successful social exchange (Scharlemann, Eckel, Kacelnik, Wilson, 2001).

Yet not all facial displays are genuine signals of underlying emotions and intentions (Ekman, 1985). We may fake expressions in order to appease and to appear trustworthy without really meaning it. In this sense, a smile can easily be 'put on' in order to give an impression of cooperativeness and trustworthiness. Such false expressions may allow access to resources that would otherwise be denied. In any culture where individuals and groups can make gains by exploiting others' trust there will therefore be cheaters who try to simulate moral emotions (Frank, 1988).

A central question is how humans distinguish between genuine emotions and fake or dishonest ones. There is evidence that facial motion conveys useful information for emotion and face perception (i.e., Ambadar et al., 2005; Lander et al., 1999). For example, the speed with which an emotion unfolds has been found to affect the perception of the expression (Kamachi et al., 2001). Given the fleeting nature of facial expressions, these differences in expression dynamics take place within a matter of milliseconds. Do these facial dynamics also provide clues about who is trustworthy?

In the research reported below we explore whether humans are sensitive to small differences in the facial dynamics of expressive behaviour when choosing whether or not to trust and cooperate in situations that have financial stakes. The smile is one of the most common and effective signals in human communication. On the other hand, it is also one of the easiest to fake (Ekman & Friesen, 1982a; Ekman et al., 1988). We therefore focus on the smile as an expression with a dual nature and explore whether facial dynamics provide important information about its quality to perceivers[3]. If facial dynamics tell us something about the genuineness of an emotion, we should be less likely to trust and cooperate when a smile seems to be fake; but if a smile expression appears to be genuine, there should be higher rates of trust and cooperation.

To test these hypotheses, we presented participants with short video clips of counterparts with whom they would play games that had financial stakes. The facial expression of the counterpart was manipulated and consisted either of a neutral expression or of one of two dynamic smile expressions. Using realistic facial animations we created subtle differences in the dynamic nature of these smiles that affected the onset, apex and offset durations[4].

Past research has shown that posed expressions have shorter onset and offset durations compared to emotion-elicited expressions of felt joy (Ekman & Friesen, 1982a; Hess & Kleck, 1990; Schmidt et al., 2006). Moreover, in two previous studies we found that smiles with longer onset and offset durations were judged to be significantly more genuine than their shorter counterparts, whereas authenticity ratings decreased the longer the smile was held at the apex (Krumhuber & Kappas, 2005; Krumhuber et al., 2007).

We therefore generated smiles that were either more 'authentic' (longer onset and offset durations, shorter apex duration) or 'fake' in their dynamic pattern (shorter onset and offset durations, longer apex duration). If facial dynamics act as an indicator of someone's trustworthiness and cooperativeness in a given situation, we predicted that a) the selection of

[3] In smile research, there has been recent evidence for a "Duchenne marker" that involves movement in the eye and cheek region in genuine smiles (Ekman et al., 1990). This morphological feature is a perceptible signal in social interaction over and above the effect of dynamic features. However, we argue that facial dynamics may themselves be sufficient to shape perceptions and strategic decisions, independent of this morphological marker.

[4] Onset duration refers to the length of time from the start of the smile until its maximum intensity, apex duration to the length of time before this maximum smile starts to decrease, and offset duration to the length of time from the end of the apex until the smile disappears.

a counterpart and b) decisions about whether to cooperate would be shaped by the dynamic quality of the smile expression. These were the questions we examined in the two experiments described below.

Experiment 3.1

Method

Participants and Design

Forty-eight female students (18-27 years, M = 19.6, SD = 1.61) at Cardiff University participated in the study for course credit or monetary compensation of £1.50. The counterpart's facial dynamics (fake smile vs. authentic smile vs. neutral expression) was the within-subjects variable and choice of fellow-player was the key dependent variable. Additional dependent variables were impressions of the other, expected cooperativeness of the other, and decisions to engage in the game.

Procedure and Materials

When participants arrived individually at the laboratory they were informed, via a computer screen, that they would take part in a game in which they and another person (their counterpart) would make a monetary choice.

Trust game. The game was structured in such a way that the participant and counterpart were each endowed with £5. The participant had to decide whether to keep the money or to pass on the entire £5 to the counterpart. If the money was passed on, the amount was doubled by the experimenter. The counterpart could then decide whether to return £7.50 to the participant or keep the £10, leaving the participant with no money. Thus there were potential gains for both players if they cooperated, but risks for the participant if the counterpart decided not to cooperate.

Counterpart's facial dynamics. To make a choice of fellow-player, participants were shown short video clips of each of three possible counterparts. It was explained that not all counterparts would cooperate and that some would try to appear to be cooperative without returning anything. One of three counterparts displayed a neutral expression, one a fake smile, and one an authentic smile. The sequence of facial expressions was counterbalanced across counterparts. To rule out possible effects of attractiveness and honest demeanor, the three female counterparts chosen for this research were matched for trustworthiness and attractiveness, as determined in a pilot study (n = 16) and were the same women used in Experiment 2.2.

Using realistic facial animations, we constructed dynamic smile expressions with standardised timing parameters for each counterpart's face. The facial model was restricted to the lower face and was shown against a neutral background movie of the same person. Thus, only the mouth region was animated, thereby allowing us to study the effects of facial dynamics independently of other morphological features (such as the 'Duchenne marker', which contracts the muscle around the eye socket and produces 'crow's feet' at the corner of the eye). To create the animations, smile parameters were extracted from the original videos of the females by setting landmarks around the mouth, jaw and the corner of the eyes. Using the mouth landmarks, an appearance model of the mouth could be constructed. The resulting appearance parameter then represented a smile as a measure of texture variation, where a full smile represented a maximum change in texture variation with respect to a neutral mouth. Varying the onset, apex, and offset durations of this parameter equated to reordering lower face textures from the original video.

Fake smiles and authentic smiles differed solely in their onset, apex, and offset durations and were synthesised at a frame rate of 25 images per second. Authentic smiles had a relatively long onset duration of 20 frames (total 0.8 s), a relatively long offset duration of

53 frames (or 2.12 s), and a relatively short apex duration of 47 frames (or 1.88 s). Fake smiles were characterised by a relatively short onset duration of 9 frames (or 0.36 s), a relatively short offset duration of 10 frames (or 0.4 s), and a relatively long apex duration of 101 frames (or 4.14 s). These parameters were derived from a previous study (Krumhuber & Kappas, 2005), in which it was found that the perceived genuineness of smiles increased as a function of onset and offset durations, and decreased as a function of apex duration.

The smile expression was operationally defined as an upper smile (lip corner pull) with mouth opening, and synthesised at a medium level of intensity. All smile stimuli lasted 120 frames (i.e., 4.8 seconds) and were preceded by one second in which the counterpart's neutral face was shown. This was done to familiarise participants with the counterpart's face before the expression was shown. The three female counterparts showing three different facial expressions were displayed in random order as movie-clips (451 x 361 pixels, 5.8 sec) and presented in Director MX 2004 (Macromedia).

Dependent Measures

Participants rated each video excerpt on a 7-point scale with respect to how likeable, attractive, and trustworthy they perceived the counterpart to be, and how cooperative they expected her to be (0 = *not at all*, 6 = *very*). Participants then chose a counterpart with whom to play the trust game. For the chosen counterpart, participants also indicated whether they would 'engage' by passing on their £5 to the counterpart, or 'exit,' thereby keeping the endowment (0 = *exit*, 1 = *engage*).

Results and Discussion

Preliminary analyses showed that there was no significant effect of counterpart identity, $F(8, 40) = 0.99, p > .05, \eta^2 = .16$. The data were therefore collapsed across the three counterparts and all dependent variables were entered into a MANOVA with a single repeated measures factor (facial dynamics). As shown in Figure 3.1, the facial dynamics of the counterpart had a powerful effect on participants' impression ratings and expectations concerning cooperation, multivariate $F(8, 40) = 24.66, p < 0.001, \eta^2 = .831$. Counterparts who showed an authentic smile were perceived as more likeable, $F(2, 94) = 108.83, p < .001, \eta^2 = .698$, attractive, $F(2, 94) = 20.81, p < .001, \eta^2 = .307$, and trustworthy, $F(2, 94) = 51.35, p < .001, \eta^2 = .522$, than those who showed a fake smile or a neutral expression. Participants also expected counterparts with an authentic smile to be more cooperative than fake smiling or non-expressive counterparts, $F(2, 94) = 76.29, p < .001, \eta^2 = .619$ (all means differ at $p < .05$ or better).

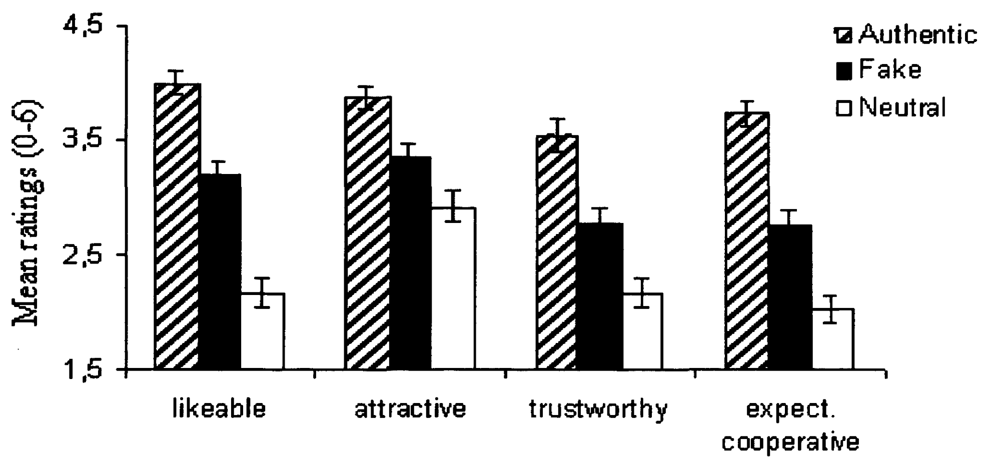

Figure 3.1. Impression ratings and expected cooperativeness of counterparts as a function of facial dynamics.

For the trust game participants were most likely to choose to play with authentically smiling counterparts, $\chi^2(2, N = 48) = 21.12, p < 0.001$. Just over 60% of participants chose a counterpart displaying an authentic smile, whereas 33.3% of participants chose a fake smiling counterpart, and 6.25% of participants chose a non-expressive counterpart. It is clear, then, that participants made use of facial dynamics in making their choice of counterpart.

There was also a significant association between choice of counterpart and subsequent decisions to engage in the game, $\chi^2(2, N = 48) = 6.28, p < 0.05$. Participants who chose a counterpart with an authentic smile were more likely than other participants to engage. More than 89% of participants with an authentically smiling counterpart decided to engage, compared with 75% of participants with a fake smiling counterpart, and 33.3% of participants with a non-expressive counterpart (Figure 3.2).

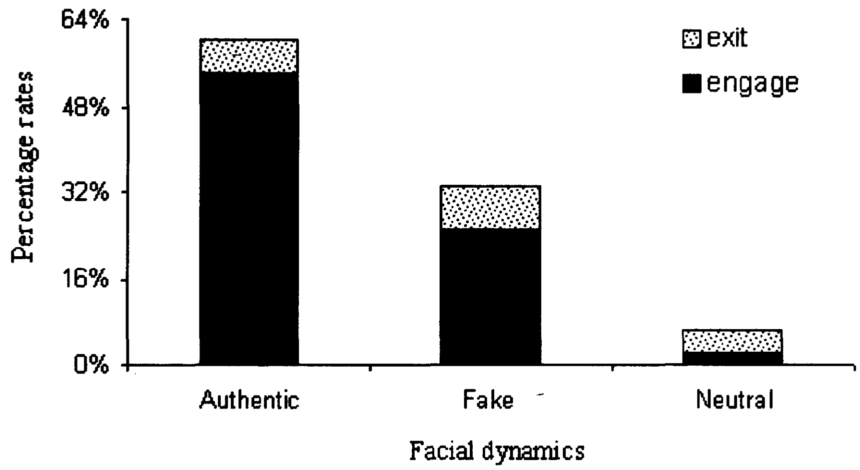

Figure 3.2. Percentage of chosen counterparts and decisions to engage/exit in the investment game as a function of facial dynamics.

These findings show that facial dynamics significantly influence the selection of a counterpart and decisions about whether to cooperate. In a situation involving trust, one's fate is at the mercy of another person. Choosing a trustworthy counterpart is likely to be key to successful exchange. Our results show that facial dynamics help to convey relevant information about this personal quality to perceivers when they have to choose whom to trust.

In real life, decisions often involve actual consequences for an individual. Moreover, there is sometimes no opportunity to choose with whom we deal. In a second experiment, we wanted to test whether humans are sensitive to the facial dynamics of another person when they participate in a trust game that is played for real money and when the fellow-player is assigned rather than chosen. Furthermore, we aimed to explore the means by which facial dynamics influence cooperation. If facial dynamics serve as an index of trustworthiness, we predicted that the effects of facial dynamics on participants' cooperative behaviour would be mediated by the perceived trustworthiness of the fellow-player.

Experiment 3.2

Method

Participants and Design

Ninety students (18-30 years, $M = 20.84$, $SD = 2.71$, 40 men and 50 women) at Cardiff University participated in the study for course credit or a snack (soft drink and potato chips). The 3 x 2 factorial design included the counterpart's facial dynamics (fake smile vs. authentic smile vs. neutral expression) and the sex of the participant (male vs. female) as between-subjects variables and cooperative behaviour as the main dependent variable. Additional dependent variables were perceptions of the counterpart, emotions, and behavioural intentions.

Procedure and Materials

Participants were instructed via computer that they would play a game for real money with another person (their counterpart). The money was paid in cash to them after the experiment. Participants were led to believe that their counterpart was seated at another computer in a separate room of the laboratory (although the 'other player' was in fact a pre-programmed strategy and always reciprocated). Prior to the actual game two trial tasks were conducted to allow participants to familiarise themselves with the structure of the game.

Trust game. The trust game was similar to the one used by Scharlemann and colleagues (2001) and consisted of a predetermined pay-off structure (see Figure 3.3). The participant and the counterpart were first endowed with £1.00 and £0.50, respectively. The participant had to decide whether to keep the £1.00 (path a in Fig. 3.3) or pass the choice to the counterpart (path b). If the participant chose to pass, the counterpart could end the game, keeping £1.25 and leaving the participant with £0.80 (path c), or pass the move back to the participant (path d). If the counterpart chose to pass, the participant could then decide between £1.20 (path e) and £1.00 payoffs (path f) for each of the players. Again, the participant's initial "trusting" move was crucial because the counterpart then had an incentive to quit, leaving the participant worse off; but if the initial trusting move were reciprocated both players would be better off.

Counterpart's facial dynamics. Just before participants began to play the game they were shown one of several short video sequences of their ostensible counterpart. It was explained that the person had been pretested on cooperativeness and trustworthiness and was videotaped while being asked about her likely strategy in the trust game. The person shown in the video was one of the three different counterparts used in the first study and displayed an authentic smile, a fake smile, or a neutral expression. The facial stimuli were exactly the same as in the first study and presented in Director MX 2004 (Macromedia).

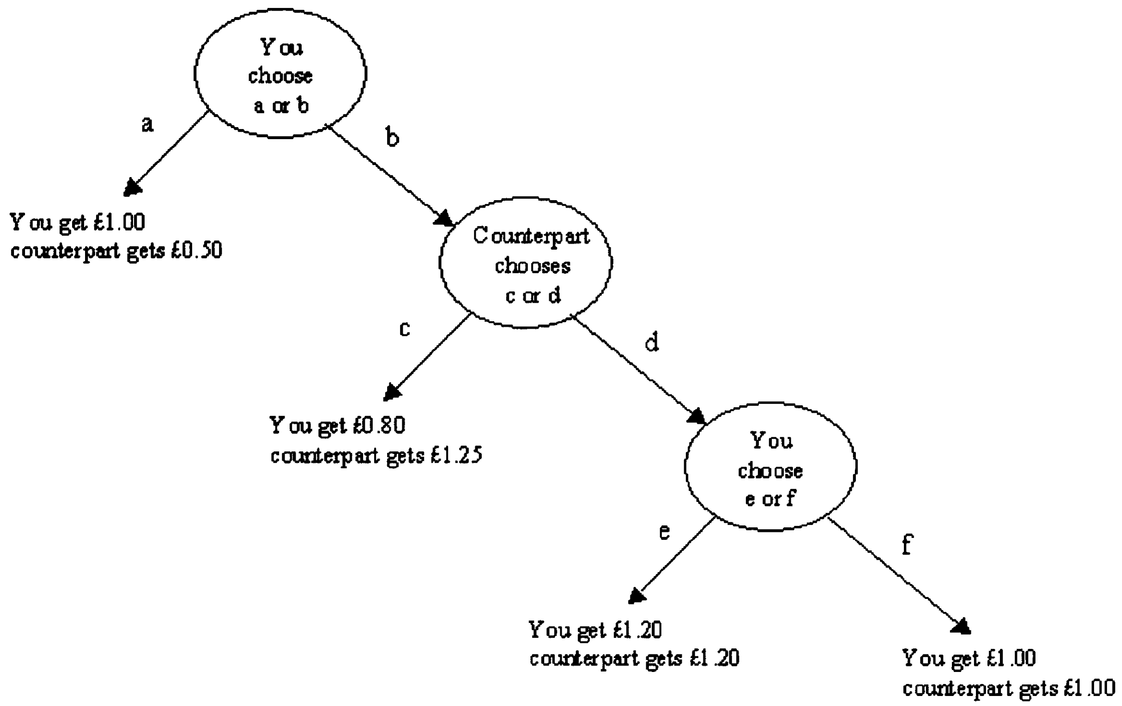

Figure 3.3. Structure of the trust game used in Experiment 3.2.

Dependent Measures

Before participants made their decisions about whether or not to cooperate (0 = not cooperate, 1 = cooperate), they rated on 7-point scales how genuine the counterpart appeared to be in the video they had seen, and how cooperative they expected the counterpart to be (0 = *not at all*, 6 = *very*). After the trust game, further impressions of the counterpart were measured by five items pertaining to the counterpart's trustworthiness, hostility, insincerity, cooperativeness, and likeability (0 = *not at all*, 6 = *very*).

In addition, participants rated how trusting, uncertain and relaxed they felt during the game (0 = *not at all*, 6 = *very*). Negatively framed items were reverse scored. With the exemption of the item "relaxed," which loaded on a separate factor, all nine judgement ratings were combined into a single index of the counterpart's perceived trustworthiness (α = .89).

At the end of the task, participants also rated their counterpart with respect to 6 emotions: happy, afraid (reverse scored), sad (reverse scored), relaxed, angry (reverse scored), and surprised (0 = not at all, 6 = very). Except for "surprised," which loaded on a separate factor, all items were averaged into a single index of the counterpart's perceived positive emotionality ($\alpha = .75$).

Participants were then asked to indicate on a 7-point scale their behavioural intentions with respect to a) how much they would like to be paired with the *same counterpart* or *a different one* if they were to play the online game again (0 = prefer other, 6 = prefer same); b) how likely it was that they would make the *same decision* again (0 = very unlikely, 6 = very likely); and c) how much they would like to *meet* the counterpart outside the context of this research (0 = not at all, 6 = very much).

Results and Discussion

Trustworthiness scores, positive emotionality scores, and the three behavioural intention measures (would prefer same counterpart, would make same decision, would like to meet) were entered into a 2 x 3 x 3 (sex of participant x identity of counterpart x facial dynamics) MANOVA. The only significant effect was the main effect of facial dynamics, multivariate $F(10, 136) = 23.09$, $p < .001$, $\eta^2 = .629$. Counterparts displaying an authentic smile were rated higher on perceived trustworthiness, $F(2, 72) = 160.75$, $p < .001$, $\eta^2 = .817$, and positive emotionality, $F(2, 72) = 85.05$, $p < .001$, $\eta^2 = .703$, than their fake smiling or non-expressive counterparts. Participants with authentically smiling counterparts also expressed greater willingness to be paired with the same counterpart again, $F(2, 72) = 37.58$, $p < .001$, $\eta^2 = .511$, and to meet outside the context of the research, $F(2, 72) = 29.12$, $p < .001$, $\eta^2 = .447$. Overall, the neutral expression was perceived most negatively, with low ratings on all dependent measures (see Figure 3.4). (All means differ at $p < .05$ or better). So showing some sort of a smile, even it had dynamic properties that led others to see it as less genuine, seems to be more advantageous than a non-expressive 'poker' face.

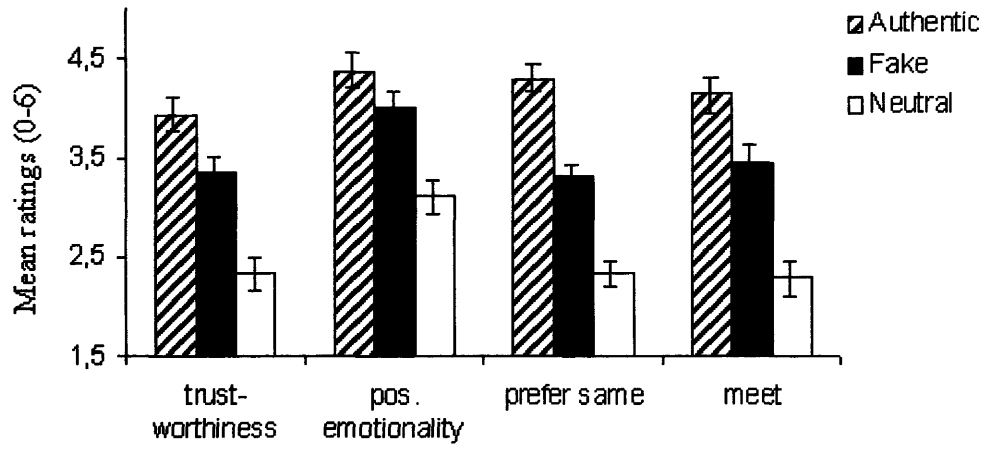

Figure 3.4. Perceptions of the counterpart and behavioural intentions as a function of facial dynamics.

Importantly, participants were more likely to cooperate with counterparts when they displayed an authentic smile than a fake smile or a neutral expression, $\chi^2(2, N = 90) = 25.62, p < .001$. Just over 93 % of participants with an authentically smiling counterpart trusted her; whereas 63.3% of participants with a fake smiling counterpart and 30% of participants with a non-expressive counterpart did so. Thus the facial dynamics of the counterpart affected the cooperative behaviour of participants in this trust game.

To explore the prediction that intentions to cooperate would be mediated by inferences of trustworthiness derived from facial dynamics, we conducted a series of regression analyses. As shown in Figure 3.5, facial dynamics predicted cooperative behaviour, as well as trustworthiness. Similarly, trustworthiness predicted cooperative behaviour. However, when controlling for trustworthiness, facial dynamics no longer predicted cooperative behaviour. Sobel's (1982) test was significant, $z(89) = 2.61$, $p < .01$, showing that the perceived trustworthiness of a counterpart mediated the effect of facial dynamics on cooperative behaviour. Facial dynamics therefore seem to provide an important basis for inferring the trustworthiness of an unknown other, and for shaping the decisions we make about trusting this other. Similar results were obtained when combined ratings of genuineness and expected cooperativeness (as measured before the trust game) were taken as mediators, $z(89) = 2.08$, $p < .05$. However, regression analyses testing for mediation by likeability were not significant, suggesting that this process was not driven by how likeable participants perceived the counterpart to be.

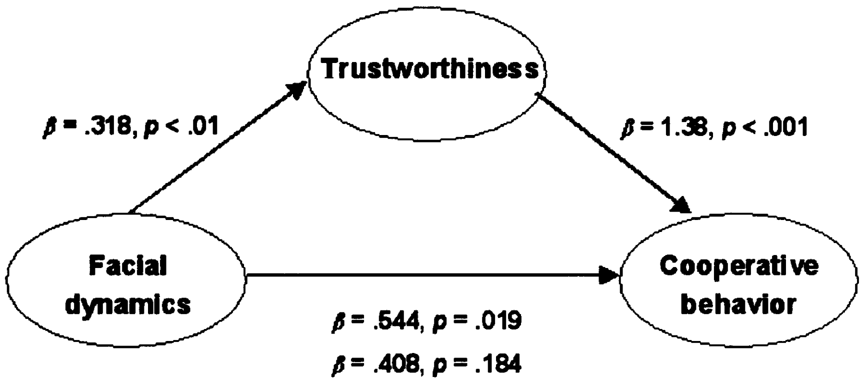

Figure 3.5. Regression analyses testing for mediation by trustworthiness of facial dynamics on cooperative behaviour.

General Discussion

In two experimental studies we demonstrated that humans are sensitive to subtle facial dynamics when choosing whether or not to trust another person in situations that have financial stakes. The facial dynamics of others as seen in video segments lasting less than 6 seconds were sufficient for participants to make inferences about the other's trustworthiness and future cooperative behaviour[5]. These findings extend recent evidence that judging

[5] A reviewer of the manuscript version of this chapter suggested that a criticism of trust game research is the fact that there are often no real monetary incentives. It is therefore interesting to note that Experiments 3.1 and 3.2 yielded similar results.

trustworthiness based on the static shape of a face can be done on the basis of very short exposure times and is a fast and intuitive process (Willis & Todorov, 2006). Functional imaging studies suggest that decisions about trustworthiness involve brain structures (such as the amygdala) that process emotions (Adolphs, 2002; Winston, Strange, O'Doherty, Dolan, 2002). Humans therefore seem to have evolved special systems that allow them to detect cheaters (Cosmides & Tooby, 2005) who fake emotions in order to appear trustworthy and cooperative. Such a view is also compatible with theories of economists who argue that a cooperative system would not have evolved if cooperators and defectors could not be distinguished (Frank, 1988).

Counterparts showing a neutral expression were rated as least trustworthy. This is interesting given that it is the fake smilers who presumably would be most likely to cheat and should therefore be least trusted. Smiling partners may appear to have an overall advantage over non-expressive partners, presumably reflecting the strong normative expectation that people should smile during self-presentation. An interesting avenue for future research would be to investigate whether facial dynamics have a similar impact in the context of negative emotional expressions (i.e., genuine vs. faked anger). This would show whether a perceived lack of trustworthiness in partners can arise from apparently inauthentic dynamics in facial expressions more generally. On the basis of the present findings for smile expressions we propose that facial dynamics may have the capacity to serve as a behavioural 'fingerprint' of someone's trustworthiness in a given situation. Fleeting facial movements convey temporal information that has an impact on whether we will trust others and cooperate with them or refrain from doing so.

CHAPTER 4

The Expression and Perception of Spontaneous and Deliberate Duchenne and Non-Duchenne Smiles

When the 2003 Oscars ceremony was transmitted live across the globe, many pundits had predicted that the epic *Gangs of New York,* directed by Martin Scorcese, would win several awards. The film was nominated in no fewer than 10 categories. One award after another went to rival films. When the award for the best director was announced, it went to Roman Polanski. Martin Scorcese reacted with a smile that involved a cheek raise, bulges around the eyes and crow's feet wrinkles – an expression that is called a Duchenne smile (Frank et al., 1993). But was Martin Scorcese happy? In the circumstances, this seems quite unlikely.

In the present research we aim to investigate this issue by adopting two approaches: a) a component approach that focuses on the sender's production of an emotional expression and treats facial behaviour as a response; and b) a judgement approach that focuses on a receiver's perception of an emotional expression and treats facial behaviour as a stimulus (Ekman, Friesen, & Ellsworth, 1982a).

Starting with the *component approach,* proponents of the facial affect program have argued that facial expressions are direct "readouts" of internal affective states (Buck, 1984). According to this view, facial expressions express emotions and are intrinsically linked to feelings (Ekman, 1982, 1992b). The Duchenne smile has been proposed to be a spontaneous marker of felt happiness and enjoyment (Ekman et al., 1990). It involves both the *zygomaticus major* muscle that produces the smiling mouth, and the *orbicularis oculi, pars lateralis* muscle. The latter muscle causes a lifting of the cheeks, narrowing of the eye-opening and wrinkles around the eye socket colloquially called crow's feet.

In terms of the Facial Action Coding System (Ekman & Friesen, 1978), a system for coding visible facial movements, these two muscle movements are coded as Action Units (AU) 6 and 12, respectively. Only smiles that involve both facial actions (i.e., Duchenne smiles) are regarded as spontaneous, felt smiles and as indicators of a positive emotion. In contrast, smiles that involve movement of the mouth only (AU 12, Non-Duchenne smiles) can readily be faked and are not regarded as a sign of felt emotions (Ekman & Friesen, 1982a).

It is argued that there is evidence of different neural pathways in spontaneous (Duchenne) and deliberate (Non-Duchenne) smiles (Rinn, 1991; Frank & Ekman, 1993). Specifically, muscles of the lower face are supposed to be involved in learned and volitionally induced behaviours and most people are able to curve their lips upwards voluntarily. The activation of the *zygomaticus major* muscle observed in Non-Duchenne smiles can therefore be produced deliberately. In contrast, the upper face and in particular the facial muscle that surround the eyes (*orbicularis oculi, pars lateralis* muscle) are much less involved in learned activities and most people (80%) are unable to contract this muscle voluntarily (Ekman, Roper, & Hager, 1980b). The presence of this movement in Duchenne smiles is therefore assumed to be a reliable sign of enjoyment and can differentiate spontaneous felt from posed unfelt expressions (Ekman, 1993).

To date there have been a number of studies showing that Duchenne smiles occurred more often when positive emotions were elicited and when people enjoyed themselves (for an overview, see Ekman, 1992c). Mostly, the presence of Duchenne and Non-Duchenne smiles was compared with respect to absolute frequencies, with higher numbers of Duchenne smiles observed in spontaneous than posed situations. The majority of these studies have been correlational in nature, suggesting a probabilistic link between Duchenne smiles and the emotion of enjoyment. Interestingly, however, the occurrence of Duchenne smiles outside spontaneous situations has not attracted research attention. Just as there are studies showing a higher frequency of Duchenne smiles in spontaneous and positively experienced contexts, there is also evidence of Duchenne smiles in posed and negative contexts (e.g., Ekman et al., 1990; Ekman et al., 1988; Schmidt et al., 2006; Schneider & Josephs, 1991; Zaalberg, Manstead, & Fischer, 2002). Together, these studies show that people can and do display Duchenne smiles in the absence of spontaneous feelings of happiness or enjoyment. Equally, not all spontaneous smiles are smiles that involve the Duchenne marker.

An interesting question that has not thus far been investigated is how voluntary and involuntary Duchenne smiles are pereceived by others. How are posed Duchenne smiles perceived? Would Martin Scorcese's Duchenne smile be judged as an enjoyment smile if it were not shown in the context of his failure to win an Oscar? Do people at some level recognise that such expressions are not 'true' Duchenne smiles? And if so, do they distinguish in their judgements between Duchenne and Non-Duchenne smiles, whether or not they originate spontaneously?

In the present research we seek to investigate spontaneous and deliberate Duchenne and Non-Duchenne smiles using both a component and a judgement approach. To our knowledge, no study has systematically looked at these different types of expressions, and the expression and perception of such displays have not been studied together. By combining the two approaches we hope to provide a fuller picture of the reliability of the Duchenne smile as a signal of spontaneously felt positive emotion, from both the sender's and the receiver's perspective.

In Study 4.1 we focus on the encoding side, and investigate whether or not people show Duchenne smiles solely or predominantly under spontaneous conditions, and show Non-Duchenne smiles solely or predominantly in deliberate conditions. Is Martin Scorcese's apparent combination of a Duchenne smile with a lack of felt positive affect an exception to the rule, or does such a combination occur more frequently? Likewise, are Non-Duchenne smiles always or predominantly voluntarily made, or do they also occur in spontaneous situations?

Studies 4.2, 4.3 and 4.4 focus on the decoding of different types of smiles. Here we examine how Duchenne and Non-Duchenne smiles are perceived, and whether people distinguish between these two smile types when they are made under spontaneous and deliberate conditions. In particular we report perceivers' ratings of these smiles with respect to spontaneity, genuineness and amusement and whether people also differentiate between Duchenne smiles accompanied by high versus moderate positive emotion (Study 4.2); the effect on these ratings of access to different facial regions (upper versus lower face; Study 4.3); and the effect on these ratings of having access to dynamic versus static images of the face (Study 4.4).

Combining the encoding and decoding perspectives, we also consider the predictive value of the Duchenne smile alongside other behavioural markers in accounting for variation in ratings of happiness and genuineness. If the Duchenne smile is a reliable marker of felt happiness, it should in principle play a major role in shaping perceivers' judgements. We therefore explore its signal value for receivers who are asked to judge in smiles, examining the extent to which it contributed to the ratings made by receivers in Studies 4.2, 4.3 and 4.4.

I. Encoding

Experiment 4.1

Although there is evidence that people show Duchenne smiles when experiencing positive emotions (for an overview, see Ekman, 1992c), a number of studies have found Duchenne smiles in negative and posed contexts. For example, Ekman et al. (1990) reported Duchenne smiles not only in reaction to positive emotional films, but also some Duchenne smiles during negative films. The negative films were intended to induce feelings of fear, sadness and disgust, and depicted accidents. Ekman et al. (1988) found that Duchenne smiles occurred in deceptive interviews as well as honest ones. In deceptive interviews, participants had to convince the interviewer that they were watching something pleasant whilst films of amputations and burns were being shown. The happiness ratings of participants in these deceptive interviews were zero. Interestingly, there were also masking smiles (including traces of negative emotion) during the honest interviews. A more recent study by Schmidt and colleagues (Schmidt et al., 2006) found Duchenne and Non-Duchenne smiles in both spontaneous and deliberate conditions. In the former condition participants smiled spontaneously; in the latter condition they were instructed to pose an expression of a basic emotion such as joy.

In the same general vein, Frank et al. (1993) found both Duchenne and Non-Duchenne smiles in solitary film-viewing conditions, as well as in social interactions when participants described their feelings to an interviewer while watching the film. This was also shown by Schmidt and colleagues (Schmidt et al., 2003), who demonstrated comparable levels of *orbicularis oculi* activity in smiles during solitary and social conditions. To explain these inconsistencies, a number of researchers have suggested that the presence of Duchenne smiles may be modulated not so much by spontaneous emotional feelings of a person, but rather by the social context (Jakobs, Manstead, & Fischer, 1999; Ruiz-Belda, Fernández-Dols, Carrera, & Barchard, 2003; Fernández-Dols & Ruiz-Belda, 1995; Zaalberg, Manstead, & Fischer, 2004). In a study by Scheider and Josephs (1991) more Duchenne smiles occurred after a failure than a success in a game, and these smiles were associated with looks directed at the experimenter. Similarly, Zaalberg et al. (2002) found Duchenne smiles shown by people who lost a game, and this was particularly pronounced when they were with a friend rather than a stranger.

Taking all these findings into account, the purpose of our first study was to systematically test the general assumption that Duchenne smiles signal spontaneous felt emotions, whereas Non-Duchenne smiles reflect posed unfelt feelings (Ekman, 1993; Ekman & Friesen, 1982a). On this assumption, Duchenne smiles should occur only, or at least predominantly, under spontaneous conditions, whereas Non-Duchenne smiles should occur only, or at least predominantly, under deliberate conditions. Moreover, feelings of amusement, pleasure and happiness on the part of senders should be present when the senders exhibit Duchenne smiles, whereas Non-Duchenne smiles should not be accompanied by these positive emotions. Thus, the goal of this study was to compare the amount of Duchenne and Non-Duchenne smiling exhibited under spontaneous and deliberate conditions, and to examine the levels of positive emotions experienced by the sender at the time these smiles occurred.

Method

Participants

Thirty-two undergraduate students (16 males, 16 females), aged 18 to 35 years (M = 22.59 years) at Cardiff University, UK participated on a voluntary basis and were paid £3.00.

Materials and Procedure

In the spontaneous condition, participants were shown six amusing stimuli intended to induce positive emotional feelings. Stimuli consisted of two jokes, one cartoon, and three film clips, each of which was approximately 15 seconds in length. These stimuli were selected from a larger pool of 34 stimuli that had been pre-tested for their capacity to evoke amusement, pleasure and happiness. Apart from a joke that had been used in a previous study, all episodes were chosen from the internet (e.g., http://www.allfunnypictures.com). The amusing stimuli were separated by filler items, i.e., 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 seconds each and were intended to return participants to a neutral emotional state.

In the deliberate condition, participants saw another six IAPS slides of inanimate objects that had similar arousal (M = 2.47) and valence scores (M = 5.01) to those of the filler stimuli, and were intended to serve as neutral stimuli. Each neutral stimulus was presented for 10 seconds. Participants were instructed to smile so that another person who would later view the videotape would be convinced that they were watching something funny. In particular, they were asked to smile as if they would feel amused. They were not allowed to talk and had to rely simply on positive facial expressions. In order to increase the stakes for success, participants were informed that they could win a prize of £10 if their smile expressions proved to be the most convincing of those made by all participants.

Participants always completed the spontaneous procedure first. This was in order to focus as little attention as possible on expressive behaviour during the spontaneous procedure. Spontaneous emotional responses would have been much less likely to occur had the order been reversed. Within each condition, stimuli were presented in one of two different sequences using MediaLab (Empirisoft) software. Participants' facial behaviour was recorded as they viewed the stimuli. Although participants were told about videotaping and consent was requested prior to the experiment, we wanted to make the recording as unobtrusive as possible. The camera was therefore concealed approximately 100 cm away from the participants in a bookshelf and was not immediately visible. None of the participants objected to the use of their video recordings.

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 (see Schmidt et al., 2003 for a similar approach). This resulted in a set of 384 smiling episodes. Facial activity during these episodes was scored using the Facial Action Coding System (FACS, Ekman & Friesen, 1978; Ekman et al., 2002). FACS allows for the measurement of all visible facial behaviour and describes it in terms of 44 action units. These are the minimal units of muscular action that are anatomically independent and visually distinguishable. For the purposes of the present research, two of these action units, AU 12 and AU 6, were treated as the primary dependent variables. As noted earlier, 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 were coded as having both AU 12 and AU 6 present constituted our sample of Duchenne smiles, whereas episodes that were coded as having only AU 12 present constituted our sample of Non-Duchenne smiles (cf. Frank et al., 1993).

For all samples in the spontaneous and deliberate epochs, we scored the frequency of AU 12 and AU 6 and also the maximum intensity (1-*trace* to 5-*maximum*) that AU 12 reached during each episode. Two coders who were blind to the different stimulus sequences within condition individually coded all the facial activity shown by the 32 participants. Each of these coders was trained in FACS scoring and their reliability in detecting *zygomaticus major* activity (AU 12) and *orbicularis oculi, pars lateralis* activity (AU 6) had been established against a FACS certified coder in a pilot study. The mean agreement ratio for these two coders was .98 for AU 12 and .94 for AU 6, demonstrating good agreement.

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 Likert scales with response options ranging from 1 (*not at all*) to 7 (*extremely*). These questions were posed in a random order, and presented in MediaLab (Empirisoft).

Results

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 (all *ps* >.07). These factors were therefore not considered any further. For each participant, proportional (frequency) or average scores (intensity, emotion) for Duchenne and Non-Duchenne smiles were computed in the spontaneous and deliberate conditions. These four scores were entered into mixed analyses of variance (ANOVA) with two within-subjects factors, Condition (spontaneous, deliberate) and Smile Type (Duchenne, Non-Duchenne), 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

Analysis of variance revealed a significant main effect of smile type on frequency of smiling, $F(1, 30) = 33.92$, $p < .001$. Overall, participants displayed more Duchenne (76.5%) than Non-Duchenne smiles (23.3%). The Condition main effect was not significant, $F(1, 30) = 2.14$, $p > .05$; nor was the interaction between Condition and Smile Type, $F(1, 30) = 3.81$, $p > .05$. Overall, 70% of smiles in the spontaneous condition were Duchenne smiles, whereas about 30% were Non-Duchenne smiles. In comparison, 83% of smiles in the deliberate condition were Duchenne smiles and about 17% were Non-Duchenne smiles. Thus, Duchenne and Non-Duchenne smiles appeared in approximately equal proportions in the spontaneous and deliberate conditions (ps > .05 across condition). The Sex of Participant main effect was not significant, $F(1, 30) = 0.43, p > .05$.

With respect to smile intensity, Duchenne smiles had higher intensity levels (M = 3.11) than Non-Duchenne smiles (M = 0.97), $F(1, 30) = 106.67, p < .001$. The main effects of Condition, $F(1, 30) = 0.01, p > .05$, and Sex of Participant, $F(1, 30) = 1.37, p > .05$, were not significant. However, there was a significant interaction between Condition and Smile Type, $F(1, 30) = 8.52, p < .01$. Analysis of simple effects showed that Duchenne smiles were significantly more intense in the deliberate condition (M = 3.37) than in the spontaneous condition (M = 2.85, $p < .05$). The corresponding difference was not significant for Non-Duchenne smiles (spontaneous: M = 1.24, deliberate: M = 0.71, $p > .05$).

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 $\alpha = .94$).

Analysis of variance showed a significant main effect of Condition, $F(1, 30) = 53.78$, $p < .001$, and smile type, $F(1, 30) = 21.67, p < .001$. 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. Furthermore, participants reported having experienced significantly more positive emotion during epochs in which they displayed Duchenne smiles (M = 2.84) than in epochs in which they displayed Non-Duchenne smiles (M = 1.43). The interaction between Condition and Smile Type was not significant,

$F(1, 30) = 0.01$, $p > .05$. Overall, Duchenne smiles were associated with more positive emotion when they were shown in the spontaneous (M = 3.74) than in the deliberate condition (M = 1.94, $p < .001$). Similarly, Non-Duchenne smiles were associated with more positive emotion when they were shown in the spontaneous condition ($M = 2.31$) than in the deliberate condition ($M = 0.55$, $p < .001$). The sex of participant main effect was not significant, $F(1, 30) = 3.79$, $p > .05$.

Discussion

It has been argued that the Duchenne smile is a reliable sign of felt enjoyment that occurs only -- or at least predominantly -- under spontaneous conditions. It has also been argued that the Non-Duchenne smile is a deliberate expression that occurs in the absence of positive emotion (Ekman, 1993; Ekman & Friesen, 1982a). The present findings cast some doubt on these arguments. Participants displayed similar proportions of Duchenne smiles under spontaneous and deliberate conditions. This shows that people are able to pose Duchenne smiles deliberately and that they do so quite frequently. On the other hand, not all the observed Non-Duchenne smiles were posed. There were equal proportions of Non-Duchenne smiles in the spontaneous and deliberate conditions. Thus there was little support for the contention that Non-Duchenne smiles reflect deliberate posing.

Intensity of expression was found to be associated with Duchenne smiles. When participants were instructed to pose smiles, Duchenne smiles were intense; indeed, they were more intense than the Duchenne smiles observed in the spontaneous condition. Thus participants were able to simulate the Duchenne smile by putting on a strong smile that also activated the upper facial muscles and thereby produced the facial features of a Duchenne smile. The emotion accompanying these deliberate Duchenne smiles was much less positive than it was for spontaneous Duchenne smiles, ruling out the possibility that they reflected subjective enjoyment. By comparison, Non-Duchenne smiles were accompanied by more positive emotion when they were shown spontaneously than when they were shown deliberately. Thus, Non-Duchenne smiles are not necessarily accompanied by no or low positive emotion.

The present findings suggest that the probability of whether someone shows a Duchenne or Non-Duchenne smile is less reflective than has been claimed of differences in felt positive emotion. There is no direct evidence that Duchenne smiles reflect spontaneity or that Non-Duchenne smiles reflect deliberateness (see Parkinson, 2005). Instead, the intensity of positive feelings and the intensity of the expression seem to determine whether or not a Duchenne smile is shown. Emotional intensity and smile intensity discriminated between the two types of smiles within and between conditions. This is consistent with findings from Messinger, Fogel, and Dickson (1999), who showed that children's smiles with and without cheek-raising were distinguished only by quantitative differences in the intensity of positive emotion (see also Messinger, 2002). These authors therefore proposed that the two smile types should be seen as a continuous emotional process, with Duchenne and Non-Duchenne smiles following one another in real time.

Below we investigate how spontaneous and deliberate Duchenne and Non-Duchenne smiles are judged by naive observers. Are Duchenne smiles originating from a deliberate condition judged to be as genuine as those arising from a spontaneous condition? It has been argued that the 'true' spontaneous Duchenne smile is mainly discernible at a low or moderate intensity level when the smiling action of the mouth would not automatically lead to a contraction of the upper face muscles, thereby making it seem as if it was a Duchenne smile. (Ekman, 1985; Frank & Ekman, 1993). We therefore conducted a series of judgement studies using those Duchenne and Non-Duchenne smiles of Study 4.1 that were of equivalent slight or marked intensity (in FACS terms), and that were produced under spontaneous or deliberate conditions. The degree of emotion accompanying these smiles was comparable within each condition.

II. Decoding

Experiment 4.2

As noted above, there is increasing evidence suggesting that both Duchenne and Non-Duchenne smiles can occur under both spontaneous and deliberate conditions. Interestingly, there is very little research investigating how these smiles are perceived and evaluated by others. Frank et al. (1993) examined whether participants who were asked to make enjoyment ratings distinguished between Duchenne and Non-Duchenne smiles with or without a duration marker (significantly longer or shorter overall duration). These smiles came either from solitary situations when viewing a film alone, or from social situations when describing the feelings during the film to an inverviewer. Senders' self-reports of enjoyment were correlated with the number of Duchenne smiles, but the researchers did not report levels of enjoyment within each sending condition. Results showed that judges could distinguish between Duchenne and Non-Duchenne smiles but this was mainly the case only for less intense smiles and when the two smile types were shown in pairs.

A study by Hess and Kleck (1994) investigated the perceived spontaneity and control of spontaneous (emotion elicited) and posed (instructed to pose) smiles and found classification rates above chance level only for spontaneous expressions. Their findings were not reported separately for Duchenne and Non-Duchenne smiles, but were instead broken down by self-reported happiness, which was greater than 3 (on a 5-point scale) for spontaneous smiles and below 1 for deliberate smiles.

In the present study, we wanted to investigate how spontaneous and deliberate Duchenne and Non-Duchenne smiles would be perceived and evaluated. For this we selected smiles of each type of Study 4.1 for which self-reports of positive emotions were moderate to high in the spontaneous condition and low in the deliberate condition. If enjoyment smiles are signaled by the Duchenne marker and if untrained judges are sensitive both to the presence of this marker and to the conditions under which it was elicited (spontaneous vs. deliberate), spontaneous Duchenne smiles should be seen as more genuine than spontaneous Non-Duchenne smiles or deliberate Duchenne smiles. A further prediction is that Non-Duchenne smiles should be judged to be equally insincere, regardless of whether they are spontaneous or deliberate. In addition, we wanted to examine whether judges distinguish between Duchenne smiles accompanied by high versus moderate emotionality within the spontaneous condition. If the emotional intensity of the sender plays a significant role in the evaluation of Duchenne smiles, highly emotional Duchenne smiles should be seen as reflecting greater subjective enjoyment than moderately emotional Duchenne smiles. All the smiles in this study were of slight or marked intensity and were presented to participants one by one.

Method

Participants

Fifty-two undergraduate students (22 males, 30 females), aged 18-33 years (M = 20.17) at Cardiff University, UK took part in this study and were given either course credit or payment of £2.00.

Stimulus Materials and Design

We included those smiles of Study 4.1 which began and ended with a neutral baseline expression and for which senders reported having felt high or moderate emotions (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 (pleasure, amusement and happiness ratings of 2 or lower) in the deliberate condition. From the total pool of smile expressions generated in Study 4.1, there were 30 smiles of each type that met the above criteria: (a) 6 spontaneous Duchenne smiles (high emotional, $M = 5.17$); (b) 6 spontaneous Duchenne smiles (moderate emotional, $M = 3.83$); (c) 6 spontaneous Non-Duchenne smiles (moderate emotional, $M = 3.93$); (d) 6 deliberate Duchenne smiles (low emotional, $M = 1.61$); and (e) 6 deliberate Non-Duchenne smiles (low emotional, $M = 1.72$).

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 introducing a standard baseline which judges could rely on to rate the genuineness of an expression. According to the FACS codings (Ekman et al., 2002), Duchenne smiles were of similar intensity in both the spontaneous and deliberate conditions ($M = 3.4$ vs. $M = 3.5$, respectively, on a 5-point measure with 1 = *trace* to 5 = *maximum*). The same was the case for Non-Duchenne smiles, which did not differ between the spontaneous and deliberate conditions with respect to intensity ($M = 2.2$ vs. $M = 2.0$). The 30 smile expressions featuring 5 different types of smiles (spontaneous Duchenne smiles-high emotion, spontaneous Duchenne & Non-Duchenne smiles–moderate emotion, deliberate Duchenne & Non-Duchenne smiles–low emotion) were displayed as movie-clips (750 x 576 pixels, 25 frames/s) in MediaLab (Empirisoft) and shown to participants in random order .

Procedure

Participants were run individually. After signing a consent form, they were told that they would be making judgements about people's facial expressions. Detailed instructions regarding the experimental task and the stimuli were presented using MediaLab (Empirisoft). The instructions were as follows:

In this experiment you are about to be shown some short video-clips of several people. Each of the people you will see in these clips was shown some amusing stimuli (i.e., funny pictures, movies and texts) that were intended to elicit positive emotional feelings and some neutral stimuli (i.e., pictures of inanimate objects) which were intended to elicit no specific emotion. The amusing stimuli resulted in smiles that were accompanied by amusement of the person, and some of the smiles you are about to see are of this type: spontaneous and reflecting genuine amusement. But if neutral stimuli were shown the person viewing them was asked to act as if they were amused. In particular, people were asked to pose a smile as if they would feel amused when they were in fact not. Some of the smiles you will see are of this type: posed and not accompanied by amusement. Your task is simply to look carefully at each smile and then make some judgements about it, including whether it is spontaneous or posed.

The video sequences could be initiated by using the mouse to click a 'Start' button on the computer screen. After each sequence, participants were instructed to respond to several judgement scales by indicating their answers. The next video sequence was started by clicking a 'Continue' button on the screen.

Dependent Variables

Participants answered the following questions on 7-point Likert-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*); (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[6]

A multivariate analysis of variance (MANOVA) with Smile (5 levels: spontaneous Duchenne high; spontaneous Duchenne moderate; spontaneous Non-Duchenne; deliberate Duchenne; deliberate Non-Duchenne) as a within-subjects factor and Sex of Participant as a between-subjects factor was conducted on the three dependent variables (spontaneous, genuine and amused)[7]. As expected, there was a multivariate main effect for Smile, $F(12, 39) = 32.16, p < .001$. It was univariately significant for all three variables: spontaneous, $F(1, 50) = 27.08, p < .001$ genuine, $F(1, 50) = 27.93, p < .001$, and amused, $F(1, 50) = 135.35, p < .001$. Planned contrast analyses showed that spontaneous Duchenne smiles were generally rated as more genuine ($ps < .001$) and amused ($ps < .001$) than Non-Duchenne smiles. Interestingly, participants also distinguished between highly and moderately emotional Duchenne smiles in the spontaneous condition. Highly emotional Duchenne smiles were judged as more genuine ($p < .05$) and more amused ($p < .001$) than the same type of smile that was accompanied by only moderate emotion (see Table 4.1). When deliberate smiles were judged, a different pattern of results was found. Here, participants did not differentiate between Duchenne and Non-Duchenne smiles when rating the genuineness of the expression ($p > .05$), showing that they perceived the two types of smiles as equally insincere. However, participants gave higher amusement ratings to Duchenne than to Non-Duchenne smiles ($p < .001$).

---

[6] Because we were interested in judgements of the five types of smiles and not in exemplar differences per se, results were collapsed across the six exemplars to investigate differences as a function of smile (spontaneous Duchenne–high emotion: $\alpha = .76$; spontaneous Duchenne–moderate emotion: $\alpha = .81$; spontaneous Non-Duchenne–moderate emotion: $\alpha = .82$; deliberate Duchenne–low emotion: $\alpha = .79$; deliberate Non-Duchenne–low emotion: $\alpha = .70$). The same procedure was applied to Study 4.3 and 4.4. A similar approach was used by Hess and Kleck (1994).

[7] Ratings of how spontaneous and genuine the smile appeared to be were consistent and highly correlated with each other ($rs > .81, ps < .001$) 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.

In addition, planned contrast analyses showed that there was a significant difference between Duchenne smiles in the spontaneous and deliberate conditions. Spontaneous Duchenne smiles attracted significantly higher genuineness ($ps < .001$) and amusement ratings ($p < .001$) than deliberate Duchenne smiles. No such difference emerged for Non-Duchenne smiles ($ps > .05$), showing that elicitation condition only played a significant role when judging Duchenne smiles.

Table 4.1

Means and Standard Errors ($N = 52$) for Dependent Measures as a Function of Smile.

		Dependent Measures			
		genuine		amused	
Condition	Smile	*M*	*SE*	*M*	*SE*
spontaneous	Duchenne (high E)	4.83_a	0.12	4.66_a	0.09
	Duchenne (mod E)	4.42_b	0.12	3.84_b	0.10
	Non-Duchenne (mod E)	3.47_c	0.14	2.56_c	0.08
deliberate	Duchenne (low E)	3.71_c	0.12	3.77_b	0.09
	Non-Duchenne (low E)	3.52_c	0.11	2.73_c	0.08

Note. All ratings were made on Likert scales from 1 to 7, with higher scores indicating greater levels of that dimension. Column means with different subscripts differ at $p < .05$ or better.

Discussion

Consistent with expectations, Duchenne smiles were rated as higher in genuineness and amusement than Non-Duchenne smiles. However, this was only the case for smiles in the spontaneous condition. Deliberately posed Duchenne and Non-Duchenne smiles were not distinguished with respect to the perceived genuineness of the expression. The finding that deliberate Duchenne smiles were rated as more amused than, but equally insincere as Non-Duchenne smiles shows a dissociation between these two types of judgement. A person's smile can apparently be judged as reflecting amusement but still create an impression that the smile is insincere. Previous researchers have tended not to ask for both types of judgement and there has been a tendency to use actors who pose Duchenne and Non-Duchenne smiles (e.g., Surakka & Hietanen, 1998; Williams, Senior, David, Lughland, & Gordon, 2001). Although judges may respond differently to these two types of smiles, this does not tell us whether these posed expressions are perceived as genuine.

When Duchenne smiles were compared across conditions, spontaneous Duchenne smiles were rated as more genuine and amused than deliberate ones. This is consistent with the assumption that there is one type of genuine, felt smile: the spontaneous Duchenne smile. Interestingly, participants also distinguished between highly and moderately emotional Duchenne smiles. The emotional intensity of a smiling person therefore appears to influence perceivers' judgements. Messinger et al. (1999) argued that Duchenne and Non-Duchenne smiles would be distinguished by levels of accompanying positive emotion. The present results show for the first time that the emotional intensity experienced by the sender results in a difference in the judged quality of spontaneous Duchenne smiles. The more happiness, amusement and pleasure the encoder felt, the more genuine and amused the associated spontaneous Duchenne smile was judged to be.

No such difference emerged for Non-Duchenne smiles in each condition. Here, as expected, participants did not distinguish between spontaneous and deliberate Non-Duchenne smiles; they gave equally low ratings of genuineness and amusement to both smile types. This is consistent with the notion that Non-Duchenne smiles, regardless of whether they are elicited under spontaneous or deliberate conditions, are judged to be less genuine.

In our next study we wanted to examine whether judgements of smiles would be affected by access to the upper or lower face only. The rationale here is that the Duchenne marker is in the upper face. Differences in the evaluation of Duchenne and Non-Duchenne smiles should therefore be absent or at least attenuated when judges only have access to the lower face.

Experiment 4.3

Studies focusing on the relative importance of the upper and lower face in emotion recognition show that different facial areas are relevant for different emotions (Ekman et al., 1972). For judgements of happiness, Boucher and Ekman (1975) found both the mouth/cheek and the eye regions to be most crucial. Other studies demonstrated that the lower region of the face alone is sufficient and even superior in the recognition of happiness (Bassili, 1979; Kerstenbaum, 1992). None of these studies, however, looked specifically at Duchenne smiles. Williams et al. (2001) investigated patterns of eye fixation in reaction to Duchenne smiles and neutral expressions. Their results showed that people directed greater visual attention to the crow's feet area (upper face) when viewing smiling than non-expressive faces. The preferential looking consisted of a higher number of eye fixations, but also of longer fixation durations. The authors explained this effect on the basis of automatic visual attention strategies that would allow humans to evaluate the authenticity of expressive signals such as smiles. Unfortunately, fixation patterns were not examined in response to Non-Duchenne smiles, which would have allowed direct comparisons with Duchenne smiles.

Tremblay and colleagues (Tremblay et al., 1993) used image manipulation techniques to vary the presence or absence of the Duchenne marker (including crow's feet wrinkles, narrowed eyes and lifted cheeks) in still photographs of smiling (strong and medium intensity) or neutral faces. Participants had to rate each expression with respect to its perceived genuineness of happiness. Interestingly, the intensity of activity in the mouth region was most indicative of a genuine smile expression. The more intense the smile, the more genuine the facial expression appeared to be. The presence or absence of crow's feet wrinkles was found to influence perceptions to only a very small degree, and then only in the case of the medium intensity smile. So the upper face seemed to be of limited influence on the authenticity ratings of these smiles. It should be noted, however, that both parts of the face were visible to participants, and that static rather than dynamic stimuli were used.

In the present study we aimed to investigate the effects of being able to see the upper or lower part of the face on perceptions of spontaneous and deliberate Duchenne and Non-Duchenne smiles presented dynamically. To our knowledge, no previous study has examined the relative importance of these two parts of the face in dynamic Duchenne and Non-Duchenne smiles originating from spontaneous and deliberate conditions. We presented participants with partial faces that showed either the upper or the lower face. Given that the Duchenne marker is by definition only visible in the upper face, we expected a significant interaction between facial part and smile type. Participants should distinguish between Duchenne and Non-Duchenne smiles when they are shown the upper face, but not when they are shown the lower face. Furthermore, judgements of spontaneous and deliberate Duchenne smiles should vary only in the upper face condition, where spontaneous Duchenne smiles should be rated as more spontaneous, genuine and amused. No such effects were predicted for smiles in the lower face version.

Method

Participants

Fifty-one undergraduate students (22 males, 29 females), aged 18 to 34 years (M = 20.57) at Cardiff University, UK took part individually either for course credit or for a payment of £3.00.

Stimulus Material and Design

The smile stimuli were the same as those used in Experiment 4.2. However, only four types of smiles were used in this study: (a) 6 spontaneous Duchenne smiles (high emotional); (b) 6 spontaneous Non-Duchenne smiles (moderate emotional); (c) 6 deliberate Duchenne smiles (low emotional); and (d) 6 deliberate Non-Duchenne smiles (low emotional). Thus, smile type (Duchenne, Non-Duchenne) and condition (spontaneous, deliberate) were treated as two separate factors. For each of the 24 expressions two partial face versions were created, 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 4.2 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 the previous experiment.

Results

The three dependent measures were entered into a multivariate analysis of variance (MANOVA) with Face (Lower, Upper), Condition (spontaneous, deliberate), and Smile Type (Duchenne, Non-Duchenne) as within-subjects factors and Sex of Participant (male, female) as a between-subjects factor. There was a significant multivariate main effect for Face, $F(3, 47) = 10.65, p < .001$. It was significant for ratings of amusement only, $F(1, 49) = 8.31, p < .01$. Smiles shown in the lower face attracted significantly higher amusement ratings ($M = 3.53$) than those shown in the upper face ($M = 3.38$). Surprisingly, the interaction between Face and Smile Type was not significant. However, there were significant multivariate main effects for Condition, $F(3, 47) = 11.49, p < .001$, and Smile Type, $F(3, 47) = 105.66, p < .001$. Univariate analyses showed that these effects were significant for all three variables: *spontaneous* (Condition, $F(1, 49) = 30.27, p < .001$; Smile type, $F(1, 49) = 38.09, p < .001$), *genuine* (Condition, $F(1, 49) = 27.51, p < .001$; Smile type, $F(1, 49) = 41.22, p < .001$); and *amused* (Condition, $F(1, 49) = 33.93, p < .001$; Smile type, $F(1, 49) = 177.80, p < .001$). In general, spontaneous smiles were perceived as more genuine and amused than were deliberate smiles ($M = 4.11$ vs. $M = 3.72$ and $M = 3.61$ vs. $M = 3.29$, respectively). Similarly, Duchenne smiles were judged higher in genuineness and amusement than were Non-Duchenne smiles ($M = 4.45$ vs. $M = 3.38$ and $M = 4.26$ vs. $M = 2.64$, respectively).

These two main effects were qualified by a significant multivariate interaction between Condition and Smile Type, $F(3, 47) = 31.64, p < .001$. In univariate terms the interaction was significant for all three dependent variables: *spontaneous*, $F(1, 49) = 23.35, p < .001$, *genuine*, $F(1, 49) = 27.40, p < .001$, and *amused*, $F(1, 49) = 89.88, p < .001$. Analyses of simple effects showed that both spontaneous and deliberate Duchenne smiles were rated as more genuine ($ps < .001$) and amused ($ps < .001$) than were Non-Duchenne smiles (see Table 4.2), indicating that participants were sensitive to the Duchenne marker in smiles originating within each condition. The difference in judgement ratings, however, was larger for smiles in the spontaneous condition.

Table 4.2
Means and Standard Errors ($N = 50$) for Dependent Measures as a Function of Smile Type and Condition.

		Smile Type			
		Duchenne smile		Non-Duchenne smile	
Measure	Condition	*M*	*SE*	*M*	*SE*
genuine	spontaneous	4.82_a	0.11	3.41_b	0.13
	deliberate	4.08_c	0.10	3.36_b	0.12
	Total	4.45	0.09	3.38	0.12
amused	spontaneous	4.68_a	0.10	2.54_b	0.09
	deliberate	3.85_c	0.09	2.74_d	0.10
	Total	4.26	0.08	2.64	0.09

Note. All ratings were made on Likert scales from 1 to 7, with higher scores indicating greater levels of that dimension. Row means not sharing a common subscript differ at $p < .001$. Column means with different subscripts differ at $p < .01$ or better.

As in Study 4.2, the results for Duchenne smiles varied significantly across the spontaneous and deliberate conditions. In particular, spontaneous Duchenne smiles attracted higher ratings of genuineness ($p < .001$) and amusement ($p < .001$) than did deliberate Duchenne smiles. There was no such difference for Non-Duchenne smiles with respect to the perceived genuineness of the expression ($p > .05$), suggesting that they were judged to be equally non-genuine. Interestingly, participants judged deliberate Non-Duchenne smiles to be more amused than spontaneous ones ($p < .01$).

Discussion

The failure to find a significant interaction between face and smile type was unexpected but also intriguing. Given that the features distinguishing Duchenne from Non-Duchenne smiles are only visible in the upper face, it seemed reasonable to expect that the ability to distinguish between these two smile types would be compromised when participants were only shown the lower face. Yet this was not the case. Interestingly, higher ratings of amusement were given to the lower face compared to the upper face. Such a finding is consistent with previous research (Bassilli, 1979; Tremblay et al., 1993) and suggests that the lower face is more influential in shaping attributions of happiness and amusement. An upward turning mouth therefore seems to be the strongest determinant of how smiles are perceived.

As in the previous study, ratings of genuineness and amusement were higher for Duchenne than Non-Duchenne smiles. Interestingly, this was the case here for both spontaneous and deliberate smiles, indicating that people could make such a distinction within each condition. When comparing Duchenne smiles across condition, however, it was the spontaneous Duchenne smile that was perceived as more genuine and amused. This replicates the findings of Study 4.2 and supports the notion that there is just one type of genuine felt smile, namely the spontaneous Duchenne smile.

Spontaneous and deliberate Non-Duchenne smiles were judged to be similar with respect to the perceived genuineness of the expression, but differed with respect to perceived amusement. As noted above, this dissociation between two types of judgement ratings may reflect the fact that someone can be seen as amused, but still judged to be showing a non-genuine expression. Surprisingly, Non-Duchenne smiles were perceived as more amused when they were deliberate rather than spontaneous. This seems odd, and suggests that there may be opposite effects in the perception of Duchenne and Non-Duchenne smiles. Whereas Duchenne smiles are perceived as more amused when they are shown spontaneously rather than deliberately, the opposite seems to be true for Non-Duchenne smiles. We will return to this unexpected finding when discussing the findings of Study 4, where similar findings were obtained.

In sum, several aspects of the present findings replicate those of the previous study. Duchenne and Non-Duchenne smiles were perceived differently both within and across conditions. Given that people could make these distinctions for the lower as well as the upper face, we inferred that dynamic qualities of the unfolding expressions might have played a role in producing these differences. In a further experiment we therefore examined whether these differences in judgements of Duchenne and Non-Duchenne smiles would be moderated by seeing static rather than dynamic images.

Experiment 4.4

Facial expressions contain dynamic information that is likely to provide information above and beyond that available in static representations. Several studies have shown that dynamics contribute to the recognition of personal identity (Bassili, 1978; Bruce & Valentine, 1988; Lander et al., 1999) and improve the recognition of emotional expressions (Ambadar et al., 2005; Bassili, 1979; Bould & Morris, in press; Wehrle et al., 2000). Having access to dynamic faces rather than static ones led to higher face and emotion recognition rates. Some studies also found that dynamic information increased intensity ratings of emotions and the perception of the realism of facial stimuli (Biele & Grabowska, 2006; Weyers et al., 2006). Moreover, the speed with which an emotion unfolded was shown to influence the perception of emotional expressions (Kamachi et al., 2001) and their rated naturalness (Sato & Yoshikawa, 2004). Small changes in dynamics are of particular relevance, given that timing has been shown to differ between spontaneous and deliberate smiles (Schmidt et al., 2006; Ekman & Friesen, 1982a; Hess & Kleck, 1990). Shorter onset and offset times were found in deliberate smiles, compared to spontaneous smiles. In two studies by Krumhuber and colleagues, dynamic aspects of smile expressions also influenced their perceived authenticity, with smiles of shorter onset and offset durations and longer apex durations being judged to be less genuine (Krumhuber & Kappas, 2005; Krumhuber et al., 2007). Dynamic displays of expressive stimuli therefore seem to provide information relevant to emotion interpretation and smile perception over and above what is available in static representations.

In the present study we examined whether static images of spontaneous and deliberate Duchenne and Non-Duchenne smiles lead to different judgement ratings from those made on the basis of dynamic displays. Participants were presented with either static or dynamic displays of Duchenne and Non-Duchenne smiles. Bearing in mind that the Duchenne marker is defined by morphological features, we predicted that people would be able to distinguish between Duchenne and Non-Duchenne smiles regardless of whether the smiles were static or dynamic. However, the ability to distinguish between spontaneous and deliberate smiles was expected to vary as a function of whether faces were static or dynamic. Specifically, static displays should result in similar ratings because dynamic information concerning the spontaneity and genuineness of a smile is absent. By contrast, we expected people to be able to distinguish between spontaneous and posed smiles with dynamic faces, with spontaneous smiles judged to be more spontaneous and genuine. This should be reflected in a significant interaction between condition and display mode.

Method

Participants

Sixty undergraduate students (30 males, 30 females), aged 18 to 32 years ($M = 22.35$) at Cardiff University, UK took part individually in this study either for course credit or for a payment of £2.00. 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 4.3 were employed: (a) 6 spontaneous Duchenne smiles (high emotional); (b) 6 spontaneous Non-Duchenne smiles (moderate emotional); (c) 6 deliberate Duchenne smiles (low emotional); and (d) 6 deliberate Non-Duchenne smiles (low emotional). These 24 smiles were shown as video clips to the participants in the dynamic mode. In the static mode, each smile expression was represented by a sequence of 5 still images that were extracted from the video sequences. Images reflected the time course of the expression and showed a neutral face, followed by the smile halfway through its onset, at its apex, halfway through its offset, and a neutral face at the end. These 5 images were displayed for the same total duration as the moving clips in the dynamic mode. In order to prevent any perceptions of motion in the static sequences, successive pairs of static images were separated by a blank screen that lasted 5 frames. The resulting 24 sequences of static image were shown to all participants in the static condition. In both conditions (static and dynamic), stimuli were shown in random order via MediaLab (Empirisoft).

Procedure and Dependent Variables

The procedure in the dynamic condition was identical to that in Experiment 4.2. 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 before. The dependent variables were the same as those used in Experiments 4.2 and 4.3.

Results

A multivariate analysis of variance (MANOVA) with Condition (spontaneous, deliberate) and Smile Type (Duchenne, Non-Duchenne) as within-subjects factors and Display Mode (static, dynamic) and Sex of Participant (male, female) as between-subjects factors was conducted on the three dependent variables. There was a significant multivariate main effect for Display Mode, $F(3, 54) = 3.53$, $p < .05$. This was significant in univariate terms only for amusement, $F(1, 56) = 5.87$, $p < .05$. Overall, static displays attracted significantly higher amusement ratings ($M = 3.64$) than did dynamic displays ($M = 3.36$). In addition, there were significant multivariate main effects for Condition, $F(3, 54) = 6.35$, $p < .01$, and Smile Type, $F(3, 54) = 115.78$, $p < .001$. Univariate analyses showed that these effects were significant for *spontaneous* (Condition, $F(1, 56) = 13.59$, $p < .01$; Smile Type, $F(1, 56) = 29.16$, $p < .001$), *genuine* (Condition, $F(1, 56) = 7.83$, $p < .01$; Smile Type, $F(1, 56) = 34.78$, $p < .001$), and *amused* (Condition, $F(1, 56) = 16.75$, $p < .001$; Smile Type, $F(1, 56) = 226.87$, $p < .001$). As in Study 4.3, spontaneous smiles were judged to be more genuine and amused than were deliberate smiles ($M = 3.99$ vs. $M = 3.74$ and $M = 3.61$ vs. $M = 3.39$, respectively). Similarly, Duchenne smiles attracted higher ratings of genuineness and amusement than did Non-Duchenne smiles ($M = 4.26$ vs. $M = 3.47$ and $M = 4.23$ vs. $M = 2.76$, respectively).

Consistent with expectations, there was a significant multivariate interaction between Condition and Display Mode, $F(3, 54) = 7.43, p < .001$. It was univariately significant for all three variables: *spontaneous*, $F(1, 56) = 21.41, p < .001$, *genuine*, $F(1, 56) = 15.06, p < .001$, and *amused*, $F(1, 56) = 14.34, p < .001$. Analyses of simple effects showed that participants discriminated between spontaneous and deliberate smiles in the dynamic, but not in the static mode.

Table 4.3

Means and Standard Errors ($N = 60$) for Dependent Measures as a Function of Display and Condition.

		Display			
		Static		Dynamic	
Measure	Condition	*M*	*SE*	*M*	*SE*
genuine	spontaneous	3.83_a	0.11	4.15_b	0.11
	deliberate	3.92_a	0.09	3.56_c	0.09
	Total	3.88	0.08	3.86	0.08
amused	spontaneous	3.65_a	0.09	3.57_{ab}	0.09
	deliberate	3.63_a	0.09	3.14_c	0.09
	Total	3.64	0.08	3.36	0.08

Note. All ratings were made on Likert scales from 1 to 7, with higher scores indicating greater levels of that dimension. Row means not sharing a common subscript differ at $p \leq .05$ or better. Column means with different subscripts differ at $p < .001$.

Inspection of the means (see Table 4.3) shows that spontaneous smiles were rated as more genuine ($p < .001$) and amused ($p < .001$) than deliberate smiles. No such difference emerged for static displays ($ps > .05$), showing that participants did not differentiate between these two types of smiles in the static mode. Moreover, they were misled by these static representations. Simple effects analyses demonstrated that significantly higher ratings of genuineness and amusement were given to deliberate smiles ($ps < .05$), and that spontaneous smiles were perceived as less genuine when shown in the static compared to the dynamic mode ($p \leq .05$). This shows that static displays led to less accurate judgements of both spontaneous and deliberate smiles.

As in Study 4.3, there was a significant multivariate interaction between Condition and Smile Type, $F(3, 54) = 17.71$, $p < .001$. In univariate terms this interaction was significant for all three dependent measures: *spontaneous*, $F(1, 56) = 24.44$, $p < .001$, *genuine*, $F(1, 56) = 34.25$, $p < .001$, and *amused*, $F(1, 56) = 53.81$, $p < .001$. Analyses of simple effects revealed a similar pattern of results as above. In general, both spontaneous and deliberate Duchenne smiles were rated as more genuine ($ps < .05$) and amused ($ps < .001$) than Non-Duchenne smiles (see Table 4.4). However, this difference was larger for smiles in the spontaneous condition. Here, higher ratings were given to Duchenne smiles, whereas lower ratings were assigned to Non-Duchenne smiles.

When comparing the two types of smiles across condition, it was found that spontaneous Duchenne smiles were judged to be significantly more genuine ($p < .001$) and amused ($p < .001$) than deliberate Duchenne smiles. This is consistent with what was found in the two previous experiments and shows the critical role played by condition in shaping the perceived quality of Duchenne smiles. Interestingly, participants also distinguished between spontaneous and deliberate Non-Duchenne smiles. Significantly lower genuineness ($p \leq .05$)

and amusement ratings ($p < .05$) were given to spontaneous than to deliberate Non-Duchenne smiles.

Table 4.4
Means and Standard Errors ($N = 60$) for Dependent Measures as a Function of Smile Type and Condition.

		Smile Type			
		Duchenne smile		Non-Duchenne smile	
Measure	Condition	*M*	*SE*	*M*	*SE*
genuine	spontaneous	4.61_a	0.11	3.37_b	0.12
	deliberate	3.91_c	0.09	3.57_d	0.10
	Total	4.26	0.08	3.47	0.10
amused	spontaneous	4.56_a	0.09	2.66_b	0.09
	deliberate	3.91_c	0.08	2.86_d	0.09
	Total	4.23	0.07	2.76	0.08

Note. All ratings were made on Likert scales from 1 to 7, with higher scores indicating greater levels of that dimension. Row means not sharing a common subscript differ at $p < .05$ or better. Column means with different subscripts differ at $p \leq .05$ or better.

Discussion

As predicted, dynamic information had a significant impact on expression perception. When seeing dynamic displays, participants distinguished between spontaneous and deliberate smiles, rating spontaneous smiles as more genuine and higher in amusement. No such differences were evident for static displays, indicating that significant information was not transmitted via static cues. This is consistent with the notion 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). Moreover, participants were misled by static information, perceiving spontaneous smiles as less genuine, and attributing more genuineness and amusement to deliberate smiles when shown in a static compared to a dynamic mode. This is to our knowledge the first evidence that static information might have a misleading effect. Given that most judgement studies use static stimuli, there is a risk that their findings do not generalise to everyday interactions in which the stimuli are typically dynamic. Furthermore, the finding that static displays were generally rated as more amused than dynamic ones shows that static expressions can result in over-attribution of emotion.

The Duchenne marker is a morphologically defined feature and its influence should therefore not depend on whether a face is static and dynamic. Indeed, the effect of the presence or absence of this marker was not moderated by display mode. Rather, the effect of this marker depended on whether the smiles were spontaneous or deliberate. Participants judged spontaneous and deliberate Duchenne smiles as more genuine and amused than the corresponding Non-Duchenne smiles. Similarly, they gave higher ratings on these dimensions to spontaneous Duchenne than to deliberate Duchenne smiles, replicating the findings of Studies 4.2 and 4.3.

As in Study 4.3, Non-Duchenne smiles were judged as more amused and when they came from the deliberate than spontaneous condition; in the present study deliberate Non-Duchenne smiles were also seen as more genuine. This provides further evidence for opposite effects in the perception of Duchenne and Non-Duchenne smiles. If the smile is spontaneous, the presence of the Duchenne marker has the predictable effect of enhancing the perceived genuineness of the expression; but if the smile is deliberate, it seems that Non-Duchenne smiles may be rather more convincing than those made spontaneously. This is may be because the greater practice humans have in both sending and receiving Non-Duchenne smiles that are made deliberately makes the deliberate version seem more ‘normal’ than its spontaneous counterpart.

The findings of this study show that static and dynamic information about the same smiles do not necessarily lead to the same judgements, particularly with respect to perceivers’ ratings of spontaneous and deliberate smiles. Although the presence of the Duchenne marker has parallel effects on judgements of static and dynamic faces, the spontaneity of an expression appears to be conveyed only by dynamic displays. This begs the question of what it is about dynamic faces that has an impact on their perceived spontaneity, genuineness, and amusement. We now turn to a consideration of the extent to which these judgements of a smile are predicted by its physical attributes.

III. Predictors of Perceived Spontaneity, Genuineness, and Amusement

In addition to the simultaneous contraction of the *zygomaticus major* muscle and the *orbicularis oculi, pars lateralis* mucle (to produce a Duchenne smile), spontaneous happy smiles have been proposed to differ from deliberate ones on other dimensions (see Frank et al., 1993, Frank & Ekman, 1993). For example, it has been proposed that spontaneous smiles are characterised by greater symmetry. Supportive evidence comes from studies by Ekman and colleagues showing that spontaneous smiles in reaction to an experimenter’s joke or a pleasant film were more symmetrical than deliberate smiles made on request (Ekman, Hager & Friesen, 1981; Hager & Ekman, 1997).

The smoothness of the movements producing a smile has also been proposed as a distinctive feature of spontaneous smiles. Weiss et al. (1987) and Hess and Kleck (1990) showed that spontaneous smiles were smoother and contained fewer irregularities (pauses and stepped intensity changes) than deliberate smiles.

Another suggested property of spontaneous smiles is the duration of temporal parameters. Specifically, the onset, apex, and offset durations of spontaneous smiles have been claimed to differ from the equivalent durations in deliberate smiles. Several studies have supported this assumption by showing longer (and smoother) onset and offset times (Hess & Kleck, 1990; Schmidt et al., 2006) for spontaneous smiles than for deliberate ones.

Of all the attributes of felt, or genuine smiles, the Duchenne marker has been proposed as the most reliable (Frank et al., 1993). Interestingly, however, the distinguishing feature, that is contraction of the *orbicularis oculi* muscle, is not only characteristic of felt smiles, but also occurs in negative emotions. According to Ekman and Friesen (1982a) contraction of the outer part of the orbicularis oculi muscle (AU 6) would also be involved when distress, pain or sadness is felt. Moreover, Ekman (1985) showed that Duchenne smiles (AU 6+12) can blend with negative emotions and occur in conjunction with facial features (i.e., frowning, dimpling, lip corner depressing) expressive of contempt, sadness or fear. It is clear, then, that negative emotions and their distinctive facial actions can co-occur with Duchenne smiles.

We wanted to test the predictive value of the Duchenne marker along with other attributes such as asymmetry, irregularity, onset-, apex-, and offset durations, and negative facial actions. If the Duchenne smile is indeed the most reliable diagnostic marker of a felt smile, its capacity to predict the ratings of smiles observed in Studies 4.2 – 4.4 should be (a) consistent, and (b) at least as great as the predictive value of the other physical attributes mentioned above.

Method

All 30 smiles used in Studies 4.2 - 4.4 were scored by a FACS certified coder who was blind to condition (i.e., spontaneous vs. deliberate) for a) asymmetry, b) irregularity, c) duration of the onset, apex and offset phases, and d) presence of negative emotional facial actions.

To measure *asymmetry*, the two sides of the face were examined together and separately. For each smiling action, the movement was scored as symmetrical if the extent of muscular action was the same on both sides of the face, or asymmetrical if the contraction was stronger on one side (Ekman et al., 1981). *Irregularity* was measured by viewing episodes both in slowed and real time. A smile was coded as irregular if the expression was characterised by discontinuities in the onset, apex or offset phases. Similarly, if the smile expression faded and re-intensified, it was scored as irregular (Hess & Kleck, 1990). *Onset time, offset time and time at apex* were measured for each smiling episode (AU12) by counting the frame numbers. Onset duration was defined 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 defined as the number of frames from first evidence of decay of the smile expression until it stopped decaying (Hess & Kleck, 1990; Ekman et al., 2002). All smile expressions were scrutinised for the presence of facial features associated with *negative emotions*. Negative emotions were coded if one or more of the following facial actions occurred during the smile: frowning (AU 4), lip pressing (AU 24), dimpling (AU 14), lip corner depressing (AU 15), lid tightening (AU 7) and lower lip depressing (AU 16). All action units have previously been identified as being associated with negative emotions (Ekman & Friesen, 1978; Ekman et al., 2002).

Results and Discussion

Multiple regression analyses were used to examine the degree to which each of the facial features (Duchenne marker, asymmetry, irregularity, onset time, apex time, offset time, negative emotions) predicted ratings of spontaneity, genuineness, and amusement. Table 4.5 shows the beta coefficients for these seven predictors for the dependent measures in Studies 4.2, 4.3 and 4.4.

Table 4.5

Summary of Multiple Regression Analyses of Ratings of Genuineness and Amusement of Smiles in Studies 4.2 - 4.4 on Seven Facial Features (Values are Standardised Regression Coefficients).

	Duchenne marker	Asymmetry	Irregularity	Onset Time	Apex Time	Offset Time	Negative Emotion
Study 4.2							
genuine	.17	-.39*	-.08	.10	.42*	-.02	-.32*
amused	.29	-.21	-.12	.13	.44**	-.08	-.42**
Study 4.3							
upper face							
genuine	.53*	-.21	-.18	-.07	.19	-.12	-.23
amused	.56*	-.20	-.11	.02	.22	-.06	-.24
lower face							
genuine	.19	-.40*	-.00	.02	.56*	.10	-.11
amused	.37	-.25	-.06	.03	.46*	.08	-.23
Study 4.4							
dynamic							
genuine	-.14	-.55**	-.02	.16	.62*	.03	-.29
amused	.34	-.19	-.08	.10	.41*	-.04	-.37*
static							
genuine	.31	.02	-.15	.01	.34	-.01	-.46*
amused	.61*	.03	-.09	.00	.21	-.04	-.36*

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

As can be seen, the beta weights for irregularity, onset time or offset time were not significant in any of the three studies. For Study 4.2, which included high and moderate emotional Duchenne smiles, significant predictors were apex duration, negative emotions, and asymmetry. The longer the apex duration, and the less negative emotion a smile displayed, the more genuine and amused it was judged to be. Furthermore, less asymmetry was associated with higher ratings of smile genuineness. Thus, symmetrical smiles were associated with higher ratings of genuineness of the expression. Interestingly, the presence or absence of the Duchenne marker did not significantly predict any of the ratings.

In Study 4.3, where participants saw different parts of the face, the pattern of results varied depending on whether the lower or upper face was shown. In the upper face condition only the Duchenne marker was a significant and positive predictor of how genuine and amused the smile was perceived to be, but for the lower face other features played a significant role. Here, apex duration and asymmetry were associated with the ratings. As in the previous study, 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 higher it was rated for genuineness. So when seeing the lower face only participants made use of features other than the Duchenne marker in order to discriminate between smiles.

In Study 4.4 either static or dynamic displays were shown and here findings varied as a function of display mode. For dynamic displays, the same three facial features as in Study 4.2 emerged as significant predictors: apex duration, asymmetry, and negative emotion. The longer the apex duration of smiles, the more genuine and amused the smile was judged to be. Similarly, less asymmetry and less negative emotion were associated with higher ratings of genuineness and amusement, respectively. For static displays, only negative emotion and the Duchenne marker significantly predicted judgements. Higher ratings of amusement were given to smiles characterised by less negative emotion and by the Duchenne marker. Similarly, less negative emotion was associated with increased ratings of smile genuineness.

In sum, the results of the three judgement studies show that facial features other than the Duchenne marker significantly predicted how genuine and amused the smile expression was perceived to be. In particular, asymmetry, apex duration, and the presence of negative emotion were consistent predictors across the three studies. This is inconsistent with the view that the Duchenne marker is the most reliable and strongest index of felt emotion. The signal value of the Duchenne smile has to our knowledge never been tested in competition with all these other physical markers. In some cases, only one feature (i.e., overall duration or symmetry or negative emotion) was measured or manipulated in the presence of the Duchenne smile, yielding evidence of the dominant role of this morphological marker (Frank et al., 1993; Gosselin, Beaupré, & Boissonneault, 2002a; Gosselin, Perron, Legault, & Campanella, 2002b). Hess and Kleck (1994) explored a combination of cues, but their results pertained more globally to spontaneous expressions per se (including both positive and negative emotions), rather than the perception of one of these emotions.

The present findings suggest that for positive emotions such as enjoyment the predictive value of the Duchenne marker may be rather limited when other features are taken into account. The Duchenne marker was only a significant predictor for ratings of the upper face and when viewing static displays. And even for static images, it predicted only how amused (but not how genuine) the smile was perceived to be. Thus the Duchenne marker may well be an important index of felt emotion in the case of static faces. For dynamic displays, however, the present research suggests that the Duchenne marker is of lesser importance than other cues in predicting ratings of smile genuineness and amusement.

General Discussion

The aim of this research was to explore the general claim that Duchenne smiles are spontaneous and reliable signs of felt enjoyment, whereas Non-Duchenne smiles reflect posed, unfelt feelings. Participants either spontaneously smiled in reaction to genuinely amusing stimuli (spontaneous condition) or were instructed to pose a smile expression (deliberate condition). In Study 4.1 we found that the proportions of Duchenne and Non-Duchenne smiles in these two conditions were similar. Whether a Duchenne or Non-Duchenne smile was shown was less a function of whether the expression was spontaneous or deliberate than of the intensity of the smile and the positive feelings reported by the sender. In particular, Duchenne smiles made in the deliberate condition were more intense and accompanied by less positive emotion than were those made in the spontaneous condition. In other words, senders could deliberately produce Duchenne smiles that were not a reflection of felt positive affect. Furthermore, it was not the case that all Non-Duchenne smiles were posed, although when they were shown spontaneously these smiles were accompanied by more positive feelings than when they were made deliberately.

In a series of judgement studies, participants were generally able to distinguish between spontaneous and deliberate Duchenne and Non-Duchenne smiles through the ratings they made of the genuineness of the smiles and the extent to which they reflected amusement. The spontaneous Duchenne smile was rated as most genuine and amused, consistent with the notion that this type of smile reflects felt positive emotion. In Study 4.2, perceivers also made different ratings of spontaneous Duchenne smiles accompanied by high positive affect and those accompanied by moderate positive affect, showing that the emotional intensity experienced by the sender had an influence on perceivers' judgements.

In Study 4.3 perceivers made similar ratings when seeing the upper or lower face, showing that differential ratings of Duchenne versus non-Duchenne and spontaneous versus deliberate smiles were made regardless of whether or not the Duchenne marker (an upper face feature) was visible. In Study 4.4 we examined whether these differential evaluations would be disrupted if perceivers did not have access to dynamic information. When they were shown a succession of static displays, perceivers failed to distinguish between spontaneous and deliberate smiles. Indeed, the static displays gave rise to incorrect judgements, in that spontaneous smiles were seen as less genuine, while higher ratings of genuineness and amusement were given to deliberate smiles when shown in the static compared to the dynamic mode. It is clear, then, that information about the genuineness of a smile expression is conveyed in dynamic displays, but not in static ones.

In the final part of the paper we considered how physical properties of smiles influenced ratings of spontaneity, genuineness, and amusement. Here it was found that the predictive value of the Duchenne marker was relatively low in comparison with other smile features such as asymmetry, apex duration, and traces of negative emotion. Indeed, the Duchenne marker was a significant predictor of ratings when perceivers were shown the upper face, rather than lower face, and when they were shown static displays rather than dynamic ones. Even in the case of static images, the Duchenne marker only predicted how amused (and not how genuine) the smile was perceived to be.

In sum, these findings show that the Duchenne smile is one of several features that distinguish spontaneous from deliberate expressions. In contrast to what is generally assumed, it is neither the most diagnostic marker nor a reliable index of spontaneous amusement smiles. People display Duchenne smiles both when spontaneously experiencing positive emotion and when deliberately posing it (i.e., Ekman et al., 1988; Schmidt et al., 2006). There is even evidence that Duchenne smiles occur in negative emotional situations (Ekman et al.,1990). Whether Martin Scorcese was happy when he did not win an Oscar is of course difficult to establish. There are several possible reasons why he displayed a Duchenne smile, but happiness is not high on the list of likely candidates. In terms of how his facial expression would have been judged by others, the present research suggests that his Duchenne smile would have led to judgements that the smile was genuine and reflected amusement if perceivers only had access to his upper face or to still photographs. If they had access to the smile dynamics, however, physical attributes other than the Duchenne marker would likely influence perceivers' inferences about the genuineness of the smile and the extent to which it reflected amusement.

To date, much of our understanding of facial expressions of emotion has come from research using static facial images (Russell, Bachorowski, & Fernandez-Dols, 2003). The Duchenne marker is discernible in static displays and has reliable effects on how smiles are seen when judged from static images. A less well understood issue is whether this marker is seen as reflecting positive emotion when it appears in dynamic real life smiles. Proponents of the facial affect program have argued that (other things being equal) a characteristic facial expression (such as a smile) exists for a limited number of "basic" emotions (such as happiness; Ekman, 1982, 1992b). In recent years this view has been challenged on empirical grounds (Fernández-Dols & Ruiz-Belda, 1997; Kappas, 2003; Reisenzein, Boerdgen, Holtbernd, & Matz, 2006). The present findings are difficult to reconcile with a theoretical position that assumes a one-to-one mapping of facial expressions onto subjective emotions. Instead, there are diverse expressive cues embedded in a continuous stream of social exchange that are linked with different emotions, motives and intentions (Parkinson, 2005). The Duchenne smile may therefore represent an "artistic truth" (Fernández-Dols & Ruiz-Belda, 1997) that is captured in static representations.

It is also worth noting that the neurological claims for different neural pathways involved in spontaneous (Duchenne) and deliberate (Non-Duchenne) smiles are not unequivocal. The neurological literature shows that it is difficult to provide a precise definition of the neural systems involved in these two processes (Pizzamiglio, Caltagirone, & Zoccolotti, 1989). Indeed, Ekman and colleagues concluded that the voluntary–involuntary dichotomy is too simple (Ekman et al., 1981). Instead these authors suggested that there are several types of voluntary and involuntary expressions, each likely to vary with respect to the underlying neural pathways (Ekman, 1984).

We have shown that Duchenne smiles occur as both felt and posed expressions, and that they were not the only feature on which judges of smiles based their ratings of genuineness and amusement. The status of the Duchenne marker as a reliable and diagnostic marker of enjoyment smiles therefore needs to be re-considered. The evidence from the present research is that by itself the Duchenne smile does not reliably reflect the spontaneity of an expression.

CHAPTER 5

The Moderating Role of Smiles in the Perception of Consistent and Inconsistent Verbal Messages

Most of our everyday communication requires the perception of facial expressions in combination with speech, not in isolation. Like facial actions, speech is a central component of human expressiveness. We are often able to describe in words what we show on the face, and vice versa. However, these two communication channels do not always combine in a consistent way. Instead, a message conveyed in the verbal channel may be attenuated or discounted by what happens in the facial channel. For example, a negative statement accompanied by a smile may be seen as less negative – or even as humorous. The interpretation of such inconsistent or conflicting communication poses a challenge for the perceiver in determining the evaluative meaning of the combined message. How do we integrate these contradictory inputs if each, taken independently, communicates a different affect? The present research addresses the perception of communications that convey either the same or different emotions in the facial and verbal channels.

A common type of inconsistency is when positive affect is apparent in the facial channel but negative affect is evident in the verbal channel. Such verbal–nonverbal positive inconsistencies can serve as the basis for humour and jokes, thereby suggesting a positive discounting process (Bugental, 1974; Mehrabian, 1970). That is, a negative message in the verbal channel is discounted when accompanied by a positive message in the facial channel. However, such conflicting messages do not always result in a positive resolution or have humorous implications (Bugental, Kaswan, & Love, 1970a). If a smile is the only positive signal, it may be interpreted as controlling the experience of negative emotions. In this context, the term 'masking smile' has proved to be useful in emotion research (Ekman &

Friesen, 1982a). As a form of false or 'unfelt' smile, its purpose is to convince the perceiver that a positive emotion is felt while negative affect is concealed. Under these conditions the negative message may not be discounted.

Previous research has aimed to determine the evaluative meaning of these inconsistent communications by studying the relative impact of verbal and nonverbal channels. Such multi-channel approaches have been pursued in different research domains, using a variety of techniques and methods. Mehrabian's research (Mehrabian & Ferris, 1967; Mehrabian & Wiener, 1967) combined vocal with facial or verbal information to express all possible combinations of three attitudes (positive, neutral, negative), thereby allowing the study of consistent and inconsistent communications. The sender's inferred attitudes were found to be less negative when a positive (as opposed to a neutral or negative) nonverbal expression accompanied a negative verbal expression. In both studies, judgements of attitude positivity increased as a function of the positivity of the facial/vocal information, and when communications were congruent rather than incongruent.

Similarly, Argyle, Alkema, and Gilmour (1972) demonstrated a positive effect of friendly nonverbal messages on the perception of both hostile and neutral verbal messages, in that such messages attracted more favourable ratings when they were shown in combination with positive nonverbal messages than when they were presented alone. Interestingly, inconsistent communications containing positive nonverbal information (i.e., friendly nonverbal, hostile verbal) led to more positive attributions than did their negative nonverbal counterparts (hostile nonverbal, friendly verbal). Both types of inconsistencies, however, were interpreted as insincere, unstable, and confusing.

This pattern of results has also been found in studies on the perception and effectiveness of counselors. Tyson and Wall (1983) found that counselors were rated more positively when they engaged in responsive nonverbal/unresponsive verbal behaviour, rather than consistently unresponsive behaviour. No such difference occurred for unresponsive nonverbal/responsive verbal behaviour combination, which yielded ratings similar to those evoked by consistently unresponsive behaviour (see also Reade & Smouse, 1980). When comparing these two types of inconsistent behaviour, counselors were rated higher (on empathy, expertness, and willingness to refer others to them, Tyson & Wall, 1983; on regard for client, and effectiveness on confrontive level, Read & Smouse, 1980) when using inconsistent communications that were positive rather than negative in the nonverbal channel. However, there was no significant difference between these two types of inconsistent communication with respect to the counselor's perceived genuineness, suggesting that neither combination was seen as genuine (Tyson & Wall, 1983).

The beneficial effect of positive nonverbal behaviour on the interpretation of incongruent verbal messages can be seen, as mentioned above, as reflecting a specific form of humour. Bugental and colleagues (Bugental et al., 1970a) showed that positive facial/negative verbal combinations (regardless of the speaker's tone of voice) were primarily judged as joking by adults. Despite the fact that unambiguous verbal messages were used, negative statements were perceived as neutral in emotional quality when shown in combination with a smile. Bugental and colleagues (1970a) also showed that adults placed less credence in such inconsistent messages, apparantly concluding that the person did not really mean what he or she was saying. Interestingly, this only applied to adults, who saw the smile as a sufficient reason to question the genuineness of the negative statement. In comparison, children made more negative evaluations of the same messages, particularly when the smile was made by a woman. Thus one could infer that positive expressions in the context of negative verbal messages may be regarded as a socially acceptable facade. Although this inconsistency is viewed positively by adults, who are familiar with social role expectations, children have yet to acquire the relevant cultural knowledge (Bugental, Kaswan, Love, & Fox, 1970b).

Another perspective on the beneficial effect of positive nonverbal behaviour comes from research on deception. Inconsistent communications comprising negative nonverbal behaviour may strike observers as more discrepant than do inconsistent communications comprising positive nonverbal behaviour, thereby leading perceivers to suspect that the sender's behaviour is deceptive (Hess, Kappas, & Scherer, 1988). In a study by DePaulo and colleagues (DePaulo, Rosenthal, Eisenstat, Rogers, & Finkelstein, 1978), the more discrepant messages became on two affective dimensions (positivity-negativity, dominance-submissiveness), the more they were viewed as deceptive. Interestingly, when deception is involved or expected, perceivers' reliance on the facial channel decreases as such discrepancy increases, with heavier reliance on 'leakier' channels such as the body or the voice (Zuckerman, DePaulo, & Rosenthal, 1981; Zuckerman, Spiegel, DePaulo, & Rosenthal, 1982).

This is not to say that positive expressions made in the context of inconsistent communications always give rise to clear and unambiguous perceptions. Research on the relative importance of face and context information suggests that expressions of positive emotions (e.g., of joy) in the context of negative situational descriptions result in more ambiguous and less intense ratings than judgements of each source alone (Wallbott, 1988). In such discrepant combinations, the facial message dominates the contextual information in determining overall judgements (Frijda, 1969; Wallbott, 1988). This is particularly the case when facial and contextual information differ on quasi-physical features, such as pleasure or arousal (Carroll & Russell, 1996). As a result, the facial displays (such as smiles) in question may be seen as a mask in the light of this negative contextual information, hiding or controlling the negative emotion (see Fernández-Dols & Carroll, 1997).

The objective of the present research is to determine the role played by positive expressions in the context of consistent and inconsistent verbal communications. Previous research has not examined how smiles moderate the perception of positive, neutral, and negative verbal messages when the smile is the only positive nonverbal communication (i.e., detached from other nonverbal cues such as gestures, postures, etc.). There is considerable evidence suggesting that smiles occur not only in conjunction with positive or neutral affect, but also when the sender experiences negative emotions such as distress or anger (Ekman & Friesen, 1982a). However, the evaluative meaning of these smiles when they are shown in combination with verbal statements that have a different affective quality is not clear. The current research seeks to explore the effects of smiles and neutral expressions in combination with verbal statements that are angry, disgusted, happy or neutral in emotional quality.

Based on previous research, we predicted that facial expressions and verbal statements would interact in shaping perceptions of emotions and genuineness. Specifically, smiles should increase the positivity of the message by making negative statements appear less negative and neutral statements appear more positive. However, these inconsistent messages involving the smile expression should be seen as less genuine than when they are accompanied by a neutral expression. When the verbal message is positive, we expect smiles to lead to higher ratings of both positivity and genuineness than neutral expressions.

A question that has not been addressed in the literature on inconsistent communication concerns the effect of smile type. Evidence suggests that happy, 'felt' smiles differ in quality from 'unfelt' smiles that are put on when the individual feels either no emotion or experiences a negative emotion (Frank et al., 1993). These qualitative differences include several attributes. One such attribute is the dynamic quality of the smile expression. Deliberate, unfelt smiles are thought to have a rather 'abrupt' appearance (Ekman & Friesen, 1982a). In previous research it has been shown that smiles with a rapid onset are perceived as less authentic than are those that have a longer and smoother onset (Krumhuber & Kappas, 2005; Krumhuber et al., 2007).

For the present study we therefore predicted that ratings of genuineness would vary not only as a function of whether the individual smiled or remained neutral, but also as a function of whether the smile was more or less authentic in terms of its dynamic quality. Specifically, in the context of negative and neutral verbal statements, we hypothesised that 'inauthentic' smiles (i.e., those with a short onset duration) would be expected (due to their deliberate, masking quality) and therefore be judged as more genuine. By contrast, in the context of positive verbal messages 'authentic' smiles (i.e., those with a longer onset duration) should be regarded as appropriate and thereby evoke higher genuineness ratings than short onset smiles.

In previous research, terms such as 'joking' or 'masking' have been given to the same type of inconsistent communication containing positive nonverbal information and negative verbal information. Given that joking and masking have quite different meanings, the role of the smile expression as either discounting negativity (joking) or hiding negativity (masking) is unclear. A message that is interpreted as joking about a negative experience will create the impression of greater positive affect than a message that is interpreted as masking negative emotion. In the current research, we therefore wanted to explore the function of smiles (as signs of happiness) in messages that convey two different negative emotions, namely anger and disgust. Although these two types of inconsistent message (i.e., smile+anger and smile+disgust) may both convey insincerity, the perceived function of smiles may differ depending on whether the verbal component communicates disgust or anger. Specifically, we predicted that smiles would make verbal information implying disgust appear humorous, leading to some discounting of the sender's negative affect, but that smiles would tend to be seen as serving a masking role when combined with verbal messages implying anger. As a result, ratings of the sender's happiness should vary significantly between the two negative statements, with smile+disgust messages being seen as reflecting more happiness than smile+anger messages. No such differences were expected for neutral expressions.

To summarise, the present study is to our knowledge the first to test systematically the effect of smile expressions on perceptions of positive, neutral and negative verbal messages. It is also the first to distinguish between smiles that are more or less authentic in their dynamic quality and to examine the impact of smiles accompanying statements implying different negative emotions, namely disgust and anger. Studying these issues requires fine control over and variation of the facial and verbal parameters of interest. We therefore elected to use facial and speech synthesis. By using graphics and lip-synching software we were able to create realistic dynamic facial expressions in combination with speech and to study their effects in two different senders. Thus, we were able to conduct a systematic study of facial and verbal information while retaining experimental control over the relevant variables.

Method

Participants

Seventy-two participants (36 males, 36 females), aged 18-31 years (M = 20.56) at Cardiff University, UK took part individually either for course credit or for a payment of £2.00.

Design

A factorial design was employed with two within-subjects factors, verbal message (anger, disgust, happiness, neutrality), and facial expression (short onset smile, long onset smile, neutral expression); and two between-subjects factors, encoder (Poser face 1, Poser face 2) and gender of participant (male, female). For each type of verbal message there were 3 exemplars, resulting in 12 different statements. The representation of facial expressions was balanced across exemplars such that a given expression was seen in every single combination with the 3 exemplars of a given type of verbal message. The 12 stimuli expressed by the two different Poser faces were presented to participants in a random order.

Stimulus Material

The stimulus material consisted of 12 brief statements that expressed anger, disgust, happiness or neutrality with respect to emotional content. The verbal statements were written in the first person and chosen from a set of 40 narratives that had been prejudged for their emotional content by 28 participants in a pilot study. Statements were retained only if they were clearly rated as angry (M = 5.2 on a 7-point scale where 0 = not at all and 6 = extremely), disgusted (M = 4.81), happy (M = 5.38), or neutral (M = 1.06) from a range of attributes (including sad, afraid and worried). Ratings on measures other than that of the target emotion were $M \leq 3.58$ for anger, $M \leq 2.11$ for disgust, and $M \leq 0.21$ for happy statements. The 3 statements that were selected for each emotion category were matched as far as possible for length, and consisted on average of 25 words. Example statements are shown in Table 5.1.

Table 5.1

Example Verbal Statements for each Type of Emotion.

Emotion	Statement
anger	My boss decided to promote his son to a position he knew I wanted. He knows I worked much harder and better than his son.
disgust	I went to visit my Granddad the other day. He spits when he talks and he managed to sneeze all over my face.
happiness	For my last birthday my friends threw me a terrific surprise party. I was given loads of great presents.
neutrality	I took Geography, Chemistry and Biology 'A' levels. My brother is doing Geography as well but he chose History and French instead.

The facial stimuli consisted of two synthetic female faces generated using Poser 6 (efrontiers) graphics software. To animate the figures with speech, we used Mimic Lip sync (DAZ studio) software, which allowed us to make the Poser figures speak in synchronisation with audio recordings (made by 2 different female speakers) of the 12 verbal statements. Each statement lasted for approximately 10 seconds and was preceded by two seconds in which the Poser figure's neutral face was shown. This was done to familiarise participants with the Poser face before she started talking. While speaking, additional movement of the figure's head, the eyes, and the eyebrows were generated fully automatically in Mimic from the input speech signal, and were intended to render the animations in a vivid and life-like way.

At the end of each verbal statement, the Poser face was animated to show either a neutral expression or one of two dynamic smile expressions that differed in onset duration. The sequence of facial expressions was counterbalanced across the 3 statements of each emotional type. For the generation of smiles, parameters were derived from a previous study (Krumhuber et al., 2007) and implemented at a frame rate of 30 images per second. All stimuli started at a neutral position for 11 frames (366 ms) and then changed linearly in one of two onset durations (4 frames or 133 ms, 16 frames or 533 ms) to a smiling face at a target intensity of 1.3 (see Figure 5 for an example of a neutral and a smile expression). In past research, short onset smiles (4 frames) were judged as significantly more inauthentic than long onset smiles (16 frames). We therefore classified smiles with a short onset duration as inauthentic, whereas those with a long onset duration as more authentic. Overall stimulus length was the same for each smile type and was 71 frames (i.e., 2.36 seconds).

The smile expression (morph target: smile teeth) was operationally defined as an upper smile and involved a lip corner pull (AU 12, Facial Action Coding System; Ekman & Friesen, 1978), together with an opening of the mouth (AU 25). To create smiles that would be natural in appearance, we chose a medium level of smile intensity. This allowed us to examine the impact of smile dynamics independently of the influence of morphological factors, such as the "Duchenne marker" (i.e., orbicularis oculi activity, AU 6). The 72 stimuli resulting from the combination of 2 Poser models, 12 verbal statements, and 3 different facial expressions were displayed in colour as movie-clips (490 x 500 pixels, M = 14 sec.) and presented via MediaLab (Empirisoft).

Figure 5. Example Poser female character displaying a neutral expression (left) and an open-mouth smile (right).

Procedure

Participants were run individually on computers using software for stimulus presentation and response registration (MediaLab). After signing a consent form, participants were informed via the computer that they were going to see some computer-generated movies in which a person would make a short statement and then display an expression. They were further told that there were small differences in the types of statement and expression they would see, and that the same expression would never be seen with a given type of statement. Their task was to indicate how they perceived each statement in combination with the facial expression. Specifically, we wanted to know how they thought the person felt about what she had just said when showing the expression.

Because computer-animated images were used, we instructed participants that the stimuli would reflect certain features of emotional statements and expressions that occur in real people in real situations. We also told them that there would be no right or wrong answers; so we were not interested in how well they were doing. Instead we were seeking to understand how people make judgements about how someone feels based on what they say and what they show on their face. Participants could initiate the video sequences by using the mouse to click a 'Start' button on the computer screen. After each sequence, they were instructed to respond to several judgement scales. Then the next video sequence could be started by clicking a 'Continue' button on the screen.

Dependent Variables

For each video excerpt participants were asked to indicate the intensity with which they thought the person felt (in relation to the statement she made) each of the following emotions: *anger, disgust, fear, happiness, neutral, sadness,* and *surprise*. The seven emotion categories were presented in a random order, with one emotion shown on a given screen. Participants then rated how *genuine* they thought the person was about her feelings when showing the expression. All questions were answered by clicking a mouse on the appropriate points of a 7-point Likert-scale with response options ranging from (1) *not at all* to (7) *very.*

Results

A multivariate analysis of variance (MANOVA) with Verbal Message (anger, disgust, happiness, neutrality) and Facial Expression (short onset smile, long onset smile, neutral expression) as within-subjects factors, and Encoder (Poser face 1, Poser face 2) and Sex of Participant (male, female) as between-subjects factors was conducted on the intensity ratings of the 7 emotions and ratings of perceived genuineness. For all univariate analyses, a Greenhouse-Geisser adjustment to degrees of freedom was applied.

The multivariate main effects for Encoder, $F(8, 61) = 1.74$, $p > .05$, $\eta^2 = .19$, and Sex of Participant, $F(8, 61) = 0.89$, $p > .05$, $\eta^2 = .10$, were not significant. Multivariate main effects were significant for Verbal Message, $F(24, 45) = 35.53$, $p < .001$, $\eta^2 = .95$, and Facial Expression, $F(16, 53) = 9.82$, $p < .001$, $\eta^2 = .75$. As predicted, these two main effects were qualified by a significant multivariate interaction between Verbal Message and Facial Expression, $F(48, 21) = 2.83$, $p < .01$, $\eta^2 = .87$. In univariate terms the interaction was significant for intensity ratings of anger, $F(5.08, 345.46) = 2.45$, $p < .05$, disgust, $F(5.06, 344.03) = 2.83$, $p < .05$, and happiness, $F(5.01, 340.82) = 2.21$, $p < .05$, and for ratings of genuineness, $F(5.11, 347.63) = 22.11$, $p < .001$.

Analyses of simple effects showed that participants' ratings significantly distinguished between smiles and neutral expressions for each type of verbal message. Surprisingly, however, they did not distinguish between smiles that were more or less authentic in their dynamic quality. The means and standard errors for the interactions are shown in Table 5.2.

When rating angry messages, participants attributed significantly less anger and less disgust when the stimulus person showed a smile compared to a neutral expression ($M = 4.49$ vs. $M = 5.21$ and $M = 3.79$ vs. $M = 4.47$, respectively). The same was the case for disgust statements, where the stimulus person was judged as feeling less disgust when she smiled than when she remained neutral ($M = 3.95$ vs. $M = 4.85$). Interestingly, less anger was attributed when disgust statements were accompanied by a long onset smile ($M = 2.43$) than by a neutral expression (M = 3.14), with short onset smiles resulting in intermediate ratings ($M = 2.79$).

Table 5.2

Means and Standard Errors ($N = 72$) for Dependent Measures as a Function of Verbal Statement and Facial Expression.

		Facial Expression							
		Long Onset Smile		Short Onset Smile		Neutral Expression		Smile Total	
Statement	Measure	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
anger	angry	4.58_a	0.17	4.39_a	0.20	5.21_b	0.15	4.49_a	0.16
	disgusted	3.83_a	0.19	3.75_a	0.21	4.47_b	0.20	3.79_a	0.18
	happy	1.81_a	0.12	$1.78_{a'}$	0.13	$1.42_{b'}$	0.09	1.79_a	0.10
	genuine	3.21_a	0.21	3.06_a	0.22	5.26_b	0.13	3.13_a	0.19
disgust	angry	2.43_a	0.17	2.79_{ab}	0.19	3.14_b	0.19	2.61_a	0.14
	disgusted	3.81_a	0.22	4.10_a	0.20	4.85_b	0.18	3.95_a	0.16
	happy	2.40_a	0.17	2.35_a	0.18	1.47_b	0.08	2.37_a	0.14
	genuine	3.03_a	0.18	2.97_a	0.19	4.71_b	0.19	3.00_a	0.15
neutrality	happy	3.25_a	0.18	2.96_a	0.16	2.22_b	0.14	3.10_a	0.14
	genuine	4.14_a	0.19	3.99_a	0.20	4.82_b	0.19	4.06_a	0.16
happiness	happy	4.65_a	0.19	4.78_a	0.18	3.72_b	0.19	4.71_a	0.15
	genuine	4.56_a	0.20	4.42_a	0.21	3.51_b	0.21	4.49_a	0.17

Note. All ratings were made on Likert scales from 1 to 7, with higher scores indicating greater levels of that dimension. Row means not sharing a common subscript differ significantly at $p < .05$ or better, with the exception of the means labelled *a'* and *b'*, which differ $p < .06$.

For both angry and disgust statements, participants judged the stimulus person as happier when she showed a smile than a neutral expression (*M* = 1.79 vs. *M* = 1.42 and *M* = 2.37 vs. *M* = 1.47, respectively). When they followed negative messages, however, these smile expressions made the person appear less genuine about her feelings by comparison with when she remained neutral (*M* = 3.13 vs. *M* = 5.26 and *M* = 3.00 vs. *M* = 4.71, respectively).

A similar pattern of results was found for neutral statements, in which the stimulus person was rated as happier when she showed a smile than when she had a neutral expression (*M* = 3.10 vs. *M* = 2.22). However, a smile in combination with a neutral message also made her appear less genuine about her feelings than when she remained neutral (*M* = 4.06 vs. *M* = 4.82). For happy statements, participants judged the stimulus person as both happier and more genuine when she showed a smile than when she remained neutral (*M* = 4.71 vs. *M* = 3.72 and *M* = 4.49 vs. *M* = 3.51, respectively). No distinction was made between smiles with long and short onset durations.

To explore the effects of smiles across different verbal messages, additional simple effects analyses were carried out on ratings of happiness and genuineness. As can be seen in Table 5.3, similar levels of genuineness were attributed to stimulus persons who displayed a smile in combination with an angry or disgust statement (*M* = 3.13 vs. *M* = 3.00). For both types of negative message, she was judged as being less genuine than when she made neutral or happy statements and then smiled (*M* = 4.06 vs. *M* = 4.49). Interestingly, although genuineness ratings were higher for positive than neutral statements accompanied by a smile expression, this difference also turned out not to be significant.

For attributions of happiness, however, participants' judgements varied significantly across the different types of verbal message. Specifically, more happiness was attributed to a stimulus person who displayed a smile following a disgust statement than an angry one (*M* = 2.37 vs. *M* = 1.79). No such difference occurred when a neutral expression was shown; this led to similarly low levels of perceived happiness following the anger and disgust statements (M = 1.47 vs. M = 1.42). Overall, smiles led the stimulus person to be judged as most happy when she made a happy statement (M = 4.71), followed by neutral (M = 3.10) and disgust statements (M = 2.37), with smiles+angry statements being rated as least happy (M = 1.79).

Table 5.3

Means and Standard Errors (N = 72) for Measures of Happiness and Genuineness as a Function of Verbal Statement and Facial Expression.

		Facial Expression							
		Long Onset Smile		Short Onset Smile		Neutral Expression		Smile Total	
Measure	Statement	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
happiness	anger	1.81_a	0.12	1.78_a	0.13	1.42_a	0.09	1.79_a	0.10
	disgust	2.40_b	0.17	2.35_b	0.18	1.47_a	0.08	2.37_b	0.14
	neutrality	3.25_c	0.18	2.96_c	0.16	2.22_b	0.14	3.10_c	0.14
	happiness	4.65_d	0.19	4.78_d	0.18	3.72_c	0.19	4.71_d	0.15
genuineness	anger	3.21_a	0.21	3.06_a	0.22	5.26_a	0.13	3.13_a	0.19
	disgust	3.03_a	0.18	2.97_a	0.19	4.71_b	0.19	3.00_a	0.15
	neutrality	4.14_b	0.19	3.99_b	0.20	4.82_{ba}	0.19	4.06_b	0.16
	happiness	4.56_b	0.20	4.42_b	0.21	3.51_c	0.21	4.49_b	0.17

Note. All ratings were made on Likert scales from 1 to 7, with higher scores indicating greater levels of that dimension. Column means not sharing a common subscript differ significantly at $p < .05$ or better.

Further correlational analyses showed that there was no significant relationship between participants' ratings of happiness and genuineness for angry and disgust statements (see Table 5.4). This was the case regardless of whether the stimulus person displayed a smile or a neutral expression, the only exception being long onset smiles following a disgust message, where happiness and genuineness ratings were positively related. For neutral messages, ratings of happiness and genuineness correlated significantly for stimulus persons who smiled, but were not significantly related when a neutral expression was shown. For happy messages, happiness and genuineness ratings were significantly and positively correlated when seen in conjunction with a neutral or a smile expression.

Table 5.4

Pearson's Correlations between Measures of Happiness and Genuineness for Verbal Statement and Facial Expression.

	Facial Expression			
Statement	Long Onset Smile	Short Onset Smile	Neutral Expression	Smile Total
anger	-0.03	0.12	-0.19	0.04
disgust	0.28*	0.21	-0.03	0.13
neutrality	0.34**	0.37**	0.10	0.32**
happiness	0.83***	0.80***	0.49***	0.83***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$, two-tailed

Discussion

The aim of the present resesarch was to explore the effects of smile expressions on perceptions of positive, neutral and negative verbal messages. Considerable evidence suggests that smiles occur not only in conjunction with a positive affect, but also when the individual feels no affect or even negative emotions (Ekman & Friesen, 1982a). In the study reported above, we tested the perceived meaning of these smiles in combination with verbal statements that conveyed different emotional qualities. We found that facial expressions and verbal communication interacted significantly in shaping perceptions of the emotional message. Specifically, smiles increased the perceived positivity of the message by making negative statements appear more positive (happy) and less negative (angry, disgusted), and neutral statements appear more positive. However, when combined with a smile expression, these messages were seen as less genuine than when they were shown in combination with a neutral expression. When the verbal message was positive, smiles consistently led to higher ratings of both positivity and genuineness than neutral expressions.

These findings are in line with previous research demonstrating an influential effect of positive nonverbal behaviour in the context of consistent and inconsistent verbal messages. In previous studies inconsistent messages involving positive nonverbal behaviour have also been rated as less sincere (Argyle et al., 1972; Bugental et al., 1970a; Mehrabian & Ferris, 1967; Mehrabian & Wiener, 1976; Read & Smouse, 1980; Tyson & Wall, 1983). The present findings extend this research by showing that smile expressions (independent of other nonverbal cues) are sufficient to shape perceptions of emotions and genuineness. Smiles can moderate perceptions of a verbal statement independently of other nonverbal signals. This has implications for multi-channel research, suggesting that the presence or absence of a smile may be sufficient to determine how the verbal message is interpreted.

A further goal of the present research was to test the perceived function of smiles (as signs of happiness) across different verbal messages. In previous research, terms such as 'joking' (Bugental, 1974; Bugental et al., 1970a; Mehrabian, 1970) or 'masking' messages (Ekman, & Friesen, 1982a; Fernández-Dols & Carroll, 1997) have been applied to the same type of inconsistent communication containing positive nonverbal information and negative verbal information. Given that joking and masking have quite different connotations, we tested the effects of smiles in conjunction with statements that conveyed different negative emotions, namely disgust and anger. Although both types of combinations were found to imply insincerity (in that they were judged as less genuine), smile+disgust messages led to higher ratings of positive affect (i.e., happiness) than did smile+anger messages. This difference was only significant for smiles, with neutral expressions being perceived as equally low in happiness whether combined with disgust or anger statements.

The findings support our assumption that smiles affect the perception of anger and disgust statements differently. Specifically, we assumed that smiles lead to some discounting of negativity in statements implying disgust, whereas their role in anger statements would be more to hide and mask negativity. Indeed there is evidence that disgust and anger differ with respect to their behavioural tendencies, with disgust being more avoidance/rejection oriented (focus on oneself) and anger being approach/attack oriented (focus on source; Frijda, 1986). Thus the smile expression may imply a more self-regulating function in the context of disgust statements, thereby creating the possibility for discounting and even humour. In constrast, for anger statements smiles may be perceived instead as a mask intended to control the expression of negative affect towards the source of the anger. As a result, different levels of happiness are attributed, with smile+disgust messages being seen as reflecting greater happiness than smile+anger messages.

The present research provides initial evidence for a differentiated role of smile expressions in the perception of negative verbal statements. Future research could extend this by examining the role of smiles in combination with verbal statements implying a range of negative emotions, such as fear, sadness and contempt. This would show whether ratings of happiness differ as a function of the approach-avoidance tendencies of negative emotional statements accompanied by a smile more generally. In parallel fashion, further studies could examine whether smile expressions have different effects when combined with different positive messages, such as those conveying admiration, pride, or elevation. Ratings of happiness may vary across these positive emotions and there might even be different levels of perceived genuineness when smiles are shown in combination with these different statements. In the present study, we found that smiling led the stimulus person to be judged as most happy when she made a happy statement, followed by neutral and disgust statements, with smiles+angry combination being rated as least happy.

We explored whether ratings of genuineness varied as a function of not simply whether an emotional statement was accompanied by a smile or a neutral expression, but also whether the smile was more or less authentic in its dynamic quality. Specifically, we predicted that smiles with a shorter onset duration would be seen as less authentic and therefore rated as more genuine (because they would be seen as more appropriate) when combined with negative and neutral statements, whereas smiles with a longer onset duration would be seen as more authentic and therefore evoke higher ratings of genuineness when combined with positive statements. In the event, there was no significant overall effect of smile type, either between or within verbal statements. This seems odd, given that exactly the same timing parameters were used in previous research (Krumhuber et al., 2007) in which it was shown that smiles with a shorter onset duration (4 frames) led to lower genuineness ratings than those with a longer onset duration (16 frames).

There are several factors that might account for the absence of an effect of smile type in the present research. First, we did not vary the emotional clarity of our verbal statements. According to Ekman, Friesen, and Ellsworth (1982b) three aspects of clarity, namely ambiguity, message complexity and intensity, determine how facial and contextual (verbal) information shape perceptions of the final message. In our research, the verbal statements were relatively unambiguous, portraying one specific emotion (rather than a blend of different emotions), and had been rated highly on the emotion scale in question. The clarity of the verbal messages may therefore not have allowed an effect of the relatively subtle facial dynamics variable to emerge. Future research could examine the influence of smile dynamics in combination with verbal messages that are ambiguous or convey a blend of two emotions (i.e., happiness and sadness). When a verbal statement allows for more than one emotional interpretation, the dynamic quality of smiles might be more influential.

A second explanation relates to the fact that we varied the dynamic properties of smile expressions, not their morphological quality. Ekman and Friesen (1982a; see also Frank et al., 1993) have proposed that genuine, felt smiles involve the 'Duchenne marker,' which creates a cheek raise and crow's feet wrinkles around the eyes. In the current research, we sought to test the effect of smile dynamics independently of the occurrence of this Duchenne marker. Although, the dynamic quality of such 'non-Duchenne' smiles has been shown to influence perceptions of sincerity and trustworthiness (Krumhuber et al., in press), it may be the case that the morphological properties of smiles would play a more significant role when smiles are seen in combination with speech. It could be argued that the expressions used in the present research are 'partial' representations of authentic and inauthentic smiles. Consistent with this view is the fact that ratings of genuineness did not differ significantly between smiles accompanying happy statements and smiles accompanying neutral statements.

In the present research we aimed for smile expressions that would be seen as plausible in combination with positive, neutral and negative verbal messages. This did not allow for extreme manipulations, but rather encouraged us to create smile expressions that varied along the dimension of genuineness. A topic for future research would be to examine the effects of smile dynamics together with the presence of the Duchenne marker in different verbal statements. Research by Wagner and Lee (1999, see also Lee & Beattie, 1998) demonstrated that much smiling, in particular Duchenne smiling, occurred when talking about negative events. It would therefore be worthwhile to examine the perceived genuineness of Duchenne smiles+negative messages, and whether participants distinguish between Duchenne and non-Duchenne smiles when rating happiness.

In the present research smile expressions followed the verbal statements made by the stimulus person, a sequence that made it more likely that the expressions would be seen as qualifying the emotional content of the statements. Thus a third explanation for the absence of an effect of smile type is that this ordering of the stimuli precluded smile dynamics from having an impact on participants' ratings. Considerable evidence (Asch, 1946; Kelley, 1950) has shown that the temporal order of positive and negative attributes presented to an audience influences how favourably the person is perceived. Given that the smiles always occurred after the verbal statement, participants may have paid less attention to the dynamic quality of smile expressions than they would have if the smiles had preceded the statements. Future research is needed to examine the effects of the dynamic properties of smiles that are presented before and during speech.

In summary, the present research provides initial evidence concerning the impact of smile expressions on perceptions of emotion and genuineness when the smiles are seen in combination with positive, neutral and negative verbal messages. It is clear that smiles moderate the interpretation of verbal statements that are consistent or inconsistent with the smiling. This provides a basis for further research on the impact of smiling when it is combined with verbal messages expressing other emotions that vary in the extent of their consistency with the emotional implications of smiling.

CHAPTER 6

General Discussion

Facial displays are inherently dynamic phenomena. They move in space and time and thereby reveal important information about the dynamic configuration of expressive events. In past research, there has been an almost exclusive reliance on static facial images at or very near the peak of emotional displays (see Bruce et al., 1996). Although such 'frozen' representations may allow differentiation between emotions (Ekman et al., 1972), there is increasing evidence that dynamic aspects contain important information that influences emotion and identity recognition (i.e., Ambadar et al., 2005; Kamachi et al., 2001; Lander et al., 1999; Pike et al., 1997). Interestingly, most of this research has focused on recognition or identification processes.

A much less investigated issue concerns the effects of dynamic aspects on the *interpretation* of facial expressions. Specifically with respect to smile expressions, there is a difference between genuinely felt smiles and false ones that are deliberately posed (Ekman & Friesen, 1982a). In previous research we found that dynamic properties of smiles significantly influenced how genuine such expressions were perceived to be and how trustworthy and attractive the smiling person was judged to be (Krumhuber & Kappas, 2005; Krumhuber et al., 2007). This research provided supportive evidence for the influential role of facial dynamics in expression and person perception. Nonetheless, there were several questions that still needed to be addressed.

The main questions were whether dynamic aspects of smiles, independently of the Duchenne marker, exert a similar effect in synthetic and human facial stimuli. Furthermore, it was unclear whether the effects of smile dynamics would extend to behavioural intentions and decisions, and to concrete situations that involved a specific social context. Further research questions concerned the importance of dynamic aspects in real smiles that were either spontaneously made or posed. Here, the reliability and predictive value of the Duchenne marker as the most diagnostic feature of genuine smiles still needed to be assessed. Finally, an important question concerned the effects of smile expressions that varied in their temporal dynamics when they were combined with speech and whether the two sources of information would interact in shaping perceivers' perceptions. The research reported in the present dissertation was intended to address these research questions and thereby to achieve a fuller understanding of the role played by dynamic aspects of facial expressions.

The current chapter is structured as follows. First, the main findings of the empirical studies reported in this dissertation will be summarised. Based on these findings a framework is then proposed that allows one to integrate the effects observed in the dissertation. The major contributions and implications of this research are then considered, followed by a discussion of the strengths and limitations of the present approach, and suggestions for future research.

Summary of the Main Findings

The aims of the research reported in Chapters 2 and 3 were to employ two specific social settings and to test whether dynamic aspects of smiles – independently of the presence of the Duchenne marker – would influence perceivers' behavioural intentions and decisions. In Chapter 2, a simulated job interview situation was used in which participants had to rate several interviewees and make subsequent hiring evaluations. I chose this social context because in previous research a beneficial effect of smiling had been found with respect to evaluations of applicants and their chances of being accepted for the job in question. However, the possible impact of different temporal forms of smiles on hiring decisions had not yet been investigated. I therefore wanted to know what the effects of varying temporal forms of interviewees' smiles would be on interview impressions and employment decisions. The nature of this social setting made it suitable to test this effect in the context of relatively 'thin-slice' displays of expressive behaviour. Furthermore, I was interested in whether facial dynamics would lead to similar impression effects and decisions when shown in synthetic faces compared to real human faces.

In the first study reported in Chapter 2 interviewees were represented by synthetic faces that exhibited authentic smiles, fake smiles or neutral expressions. The two smile types differed only in their onset, apex and offset durations; there was also a neutral control condition. The results showed that interviewees displaying authentic smiles were evaluated more favourably on the job, person, and expression scales than their fake smiling or neutral counterparts. In addition, they were also judged to be more suitable for the job, and more likely to be short-listed and selected. Overall, the neutral expression was perceived most negatively, with low ratings on all measures. The second study reported in Chapter 2 was identical with respect to design and procedure, except that interviewees were represented by real human faces. As in the previous study, dynamic authentic smiles led to more favourable ratings of interviewees with respect to job, person and expression attributes than did fake smiles or neutral expressions. Interviewees displaying dynamic authentic smiles were also judged to be more suitable for the job, and more likely to be short-listed and selected.

Taken as a whole, the results of the two studies reported in Chapter 2 show that dynamic information leads to similar judgements of synthetic and human faces. Results based on the study of synthetic facial stimuli may therefore be generalisable to the perception of human faces. In both studies, dynamic aspects of smiles had a powerful effect not only on impressions of the interviewee, but also on subsequent hiring decisions. *How* a job applicant smiles therefore has the potential to affect whether or not he or she is hired for the job. That such effects were observed in a specific social setting extends previous research and suggests that smiles can give rise to different impressions and employment decisions, depending on their dynamic qualities. Relatively brief glimpses of dynamic information seem to be sufficient to shape behavioural intentions.

In the research reported in Chapter 3, I examined the influence of smile dynamics on strategic choices made in two trust game scenarios. Although smile expressions had previously been found to have a positive effect on cooperation and trust, earlier studies had simply compared smiling faces with neutral ones. The aim of the two studies reported in this chapter was therefore to explore whether dynamic aspects of smiles would act as markers of cooperative behaviour and trustworthiness. Specifically, I was interested in whether humans are sensitive to these dynamic cues in their choice of counterpart and when deciding whether or not to trust and cooperate.

In the first study reported in Chapter 3, participants could choose a counterpart with whom to play a trust game involving financial stakes. Fellow players were the three human female actors already used in the job interview study. As in that study, they displayed an authentic smile, a fake smile, or a neutral expression. Again, these expressions differed only in their onset, apex and offset durations. Consistent with expectations, counterparts who showed authentic smiles were perceived as more likeable, attractive and trustworthy than those who showed a fake smile or a neutral expression. Participants also expected counterparts with authentic smiles to be more cooperative than fake smiling or non-expressive counterparts. Participants were also more likely to choose to play with authentically smiling counterparts than with fake smiling and non-expressive counterparts. From those participants who chose a counterpart with an authentic smile, the vast majority of participants decided to engage (a trusting move), compared with three-quarters of participants who chose a fake smiling counterpart, and approximately one-third of participants who chose a non-expressive counterpart.

In the second study reported in Chapter 3 another trust game scenario was employed. This was played for real money and the fellow-player was assigned rather than chosen. The facial stimuli were identical to those used in the previous study. I was mainly interested in how the different expressions would affect participants' decisions to cooperate. Furthermore, I aimed to test whether any observed influence of facial dynamics on cooperative behaviour would be mediated by perceived trustworthiness. Participants were most likely to cooperate with counterparts when they displayed an authentic smile, followed by counterparts who showed a fake smile and those who displayed a neutral expression. Counterparts displaying authentic smiles were rated higher on perceived trustworthiness and positive emotionality than their fake smiling or non-expressive counterparts. Participants with authentically smiling counterparts also expressed greater willingness to be paired with the same counterpart again, and to meet outside the context of this research. Overall, the neutral expression was perceived most negatively, with low ratings on all measures. In further analyses we showed that the influence of facial expression on cooperation was mediated by perceived trustworthiness.

The two studies reported in Chapter 3 show that participants were sensitive to subtle facial dynamics when choosing with whom to play and whether to cooperate with the other person. Moreover, person attributions, emotional feelings and behavioural intentions were influenced by facial dynamics. Temporal qualities of facial displays can therefore act as a powerful cue in influencing cooperation and behavioural intentions. This extends previous research by showing that smiles can convey different signals for cooperative behaviour depending on their dynamic nature. Smiles seen in video segments lasting less than 6 seconds were a sufficient basis for making these evaluations. Thus, rapid inferences can be made on the basis of short exposures to others' facial behaviour. Moreover, the effects of smile dynamics on cooperation were found to be mediated by the perceived trustworthiness of the fellow-player. The dynamic aspects of smiles therefore seem to provide a basis for inferring the trustworthiness of an unknown other, and for shaping the decisions we make about whether or not to trust this other.

In the research reported in Chapter 4, I aimed to test the impact of facial dynamics in real smiles that were either spontaneously made or posed. A common claim made in the literature on smiling is that the Duchenne marker is the most reliable feature – and therefore more diagnostic than dynamic markers – way of distinguishing between spontaneous ('felt') and posed ('unfelt') smiles. Interestingly, no prior research has systematically examined the reliability and validity of this morphological marker. In the first study reported in Chapter 4, participants either spontaneously smiled in reaction to genuinely amusing stimuli or were instructed to pose a smile expression. There were similar proportions of Duchenne and Non-Duchenne smiles made in these two conditions. Duchenne smiles made in the deliberate condition were more intense and were accompanied by less positive emotion than were those made in the spontaneous condition. That is, senders could deliberately produce Duchenne smiles that were not a reflection of felt positive affect. The occurrence of Duchenne and Non-Duchenne smiles therefore seems to be less a function of spontaneity or deliberateness, but rather of the intensity of the smile and the positive feelings reported by the sender.

In a series of judgement studies (Chapter 4, Studies 2 – 4), it was found that participants were generally able to distinguish between these spontaneous and deliberate Duchenne and Non-Duchenne smiles. In all cases, spontaneous Duchenne smiles was rated as most genuine and amused, consistent with the notion that this type of smile reflects felt positive emotion. In Study 4.2, perceivers also made different ratings of spontaneous Duchenne smiles when they were accompanied by high versus moderate positive affect. The emotional intensity experienced by the sender therefore seems to influence perceivers' judgements.

Study 4.3 showed that such a differentiation was also made when seeing the upper or lower face only. That is, ratings of Duchenne versus non-Duchenne and spontaneous versus deliberate smiles differed regardless of whether the Duchenne marker (usually thought of as an upper face feature) was visible or not. However, in Study 4.4 these differential evaluations were shown to be disrupted when perceivers saw static rather than dynamic displays. More specifically, when they were shown sequences of static displays perceivers failed to distinguish between spontaneous and deliberate smiles. Moreover, these 'multi-static' displays gave rise to incorrect judgements, in that spontaneous smiles were rated as less genuine than deliberate smiles, and higher ratings of genuineness and amusement were given to deliberate smiles in the static compared to the dynamic mode. Thus information concerning the spontaneity of an expression appears to be conveyed by dynamic displays.

Combining the expresser and perceiver aspects of the research reported in Chapter 4, the predictive value of the Duchenne smile in accounting for variation in perceivers' ratings was considered alongside other dynamic and behavioural markers. Interestingly, the Duchenne marker accounted for relatively little variance by comparison with smile features such as asymmetry, apex duration, and traces of negative emotion. Indeed the Duchenne marker was only a significant predictor of ratings made of the upper face, and ratings made when viewing static displays. Even for these static images, the Duchenne marker predicted how amused, but not how genuine, the smile was perceived to be.

Taken together the findings of the research reported in Chapter 4 show that the Duchenne marker is one of several features that distinguish between spontaneous and deliberate expressions. However, there was no evidence that Duchenne smiles occurred only in conjunction with spontaneous, felt emotions, and that Non-Duchenne smiles reflected posed, unfelt feelings. Senders displayed Duchenne smiles both when spontaneously experiencing positive emotion and when deliberately posing it. Moreover, the value of the

Duchenne marker in predicting perceivers' judgements of genuineness and amusement was rather limited and achieved significance only for ratings of the upper face and of static displays. The status of the Duchenne marker as a reliable and valid marker of enjoyment is therefore due for reassessment. Compared to other dynamic and behavioural features, it was neither the most diagnostic marker nor a reliable index of spontaneous amusement smiles.

In the study reported in Chapter 5, my main objective was to examine the effects of smile expressions with different temporal dynamics when they were shown in combination with speech. The possibility that dynamic smile expressions moderate the interpretation of consistent and inconsistent verbal messages had not been previously investigated. I was also interested in whether judgements of a sender's emotional state would vary as a function of the dynamic properties of the smile expression when she said something about how she was feeling. For example, what impact would smiles with differing temporal attributes have in the context of verbal messages conveying negative emotions? Senders made angry, disgusted, happy or neutral statements and then showed one of two temporal forms of smiles (slow versus fast onset), or a neutral expression.

Facial expressions and verbal messages interacted significantly in shaping perceptions of emotional state and of genuineness. Smiles increased the positivity of the message by making negative statements appear more positive and less negative, and by making neutral statements appear more positive. These inconsistent messages involving the smile expression, however, were seen as less genuine than when they were shown in combination with a neutral expression. When the verbal message was positive, smiling expressions led to higher ratings of both positivity and genuineness than did neutral expressions. Interestingly, smiles had different effects in the context of anger and disgust statements. Although both types of statements were seen as implying insincerity, smile+disgust messages led to higher ratings of positive affect (i.e., happiness) than did smile+anger messages. However, the effect of smile type was not significant, indicating that participants did not distinguish between smiles that were more or less authentic in their dynamic qualities.

Taken together, these findings from Chapter 5 suggest that smile expressions can shape perceptions of emotions and genuineness. This extends previous research by showing that smiles can moderate perceptions of emotional state evoked by a sender's verbal statements. Furthermore, ratings of emotion and genuineness were not equally affected by smiles accompanying emotionally negative verbal statements. Smiling led to different attributions of happiness depending on whether anger or disgust was conveyed in the verbal channel. In the case of disgust statements, I speculated that smiles may have a more self-regulating function, with the result that they are seen as attenuating the negativity implicit in the verbal statement. In contrast, smiles made in the context of anger statements may be perceived as masking true feelings and therefore fail to evoke any perceptions of happiness. This research provides the first evidence that the role played by smile expressions in the context of negative verbal statements varies as a function of the emotion conveyed by the verbal statements. Surprisingly, the temporal form of smiling had no effect on judgements. Several possible reasons for this absence of effect were identified, including the emotional clarity of the verbal statements, the morphological form of the smiles, and stimulus order.

Toward an Integrative Framework

Differentiating between genuine felt and posed or false smiles is one of the key distinctions made in research on smiling. In order to distinguish between them, several markers have been suggested that are morphological or dynamic in nature (Ekman & Friesen, 1982a). Until now, the Duchenne marker has attracted most attention in distinguishing these two types of smiles (see Ekman, 1992c). Partly because it is easy to detect in static displays, it has been proposed that this morphological marker is the most reliable feature of felt enjoyment smiles (Frank & Ekman, 1993). By comparison, very little research has focused on dynamic markers and their contribution to the differentiation between smile types. Although there is some evidence that spontaneous smiles differ from posed ones in their dynamic qualities (Bugental, 1986; Hess & Kleck; 1990; Schmidt et al., 2006; Weiss et al., 1987), the role of dynamic aspects in the perception of smile expressions, prior to the research reported in this dissertation, was not clear.

As illustrated in Figure 6, with respect to how smiles are perceived by others, I set out in the present dissertation to explore the influence of dynamic properties of smiles. By manipulating dynamic parameters, I systematically investigated whether humans are sensitive to facial dynamics in their perceptions of both expression and expresser, and in making decisions. These processes were studied in the context of particular social situations, and in both synthetic and human faces, always in the absence of the Duchenne marker. In similar vein, the effects of smile expressions that vary in dynamic quality were also examined in combination with consistent and inconsistent verbal communication. It is argued that these studies of how dynamic aspects of the human smile influence perceivers constitute a significant advance in what we know about the influence of facial dynamics.

A further feature of the present research is that I studied the importance of dynamic information in real smiles (as opposed to manipulated ones) that were either spontaneously made or posed. With respect to the expression of emotion, the reliability and validity of the Duchenne marker in distinguishing between these two smile types was explored. Specifically, I examined the occurrence of the Duchenne marker, its intensity, and its link to positive emotions. I also studied the impact of the Duchenne marker on perceivers, exploring whether they differed significantly in their ratings of Duchenne and non-Duchenne smiles under various conditions: when the smiles were accompanied by high versus moderate positive emotion; when perceivers had access to the upper versus lower face only; and when perceivers saw static versus dynamic images. Furthermore, the predictive value of the Duchenne marker was explored, alongside other dynamic and behavioural features, in accounting for these judgements.

Consistent with expectations, the studies reported in Chapters 2 and 3 demonstrated that dynamic qualities of smiles had a significant impact on how smile expressions were perceived, on perceptions of the smiling person and on decisions and behavioural intentions. In Chapter 5, the role of temporal dynamics was found to be more complex when smiles were seen in combination with speech. Although no overall effect of dynamic properties emerged, smiles with different temporal forms interacted significantly with whether they were accompanied by verbal messages that were emotionally consistent or inconsistent in emotional quality in shaping perceiver ratings.

Turning now to the research on real smiles, as opposed to manipulated ones, in Chapter 4 it was shown that the Duchenne marker is a less reliable indicator of the difference between spontaneous and posed smiles than has been previously claimed. Perceivers were generally influenced by the presence or absence of the Duchenne marker, such that they were able to distinguish between spontaneous and deliberate Duchenne and Non-Duchenne smiles. However, this differentiation was also made when seeing the lower face only, which shows that perceivers were not dependent on the eye-region in making their judgements. Interestingly, perceivers did not distinguish between spontaneous and posed smiles when they were shown static displays rather than dynamic ones, suggesting that dynamic information also plays a crucial role in the perception of real smiles. When testing the value of the Duchenne marker in accounting for perceivers' ratings, I found its predictive power to be rather limited relative to other dynamic and behavioural features. Specifically, it was only a significant predictor of ratings when perceivers were shown the upper face and when they saw static displays.

Together these findings suggest a theoretical framework that stresses the importance of facial dynamics not only with respect to judgements made by the perceiver, but also in relation to the Duchenne marker with respect to expressions made by the sender and judgements made by the perceiver. From the results of this dissertation, it can be confidently asserted that dynamic information has a significant impact on perceptions and attributions on the part of the perceiver. This extends previous research (Bugental, 1986; Hess & Kleck, 1994; Hess et al., 1989) by showing that dynamic aspects have a communicative value that is both perceptible and meaningful to perceivers. Furthermore, the Duchenne marker has been shown to have less power to discriminate between spontaneous and posed smiles than has been previously claimed in relation to both expression and perception (Frank & Ekman, 1993). It is certainly not an exclusive sign of spontaneity. The fact that it was shown to have predictive value in relation to judgements of static displays and the upper face only could be seen as consistent with past research that has been dominated by the use of static facial images. In comparison to dynamic markers, the Duchenne marker is therefore neither a stronger nor a more diagnostic reflection of the difference between spontaneous and posed smiles. Its reliability and validity as the most diagnostic feature needs to be reappraised. The results of the present research show that dynamic aspects of facial expressions are an equally powerful way of distinguishing between these two smile types. This adds to past research by establishing the status of dynamic information and in doing so encourages the use of dynamic rather than static facial stimuli in future research.

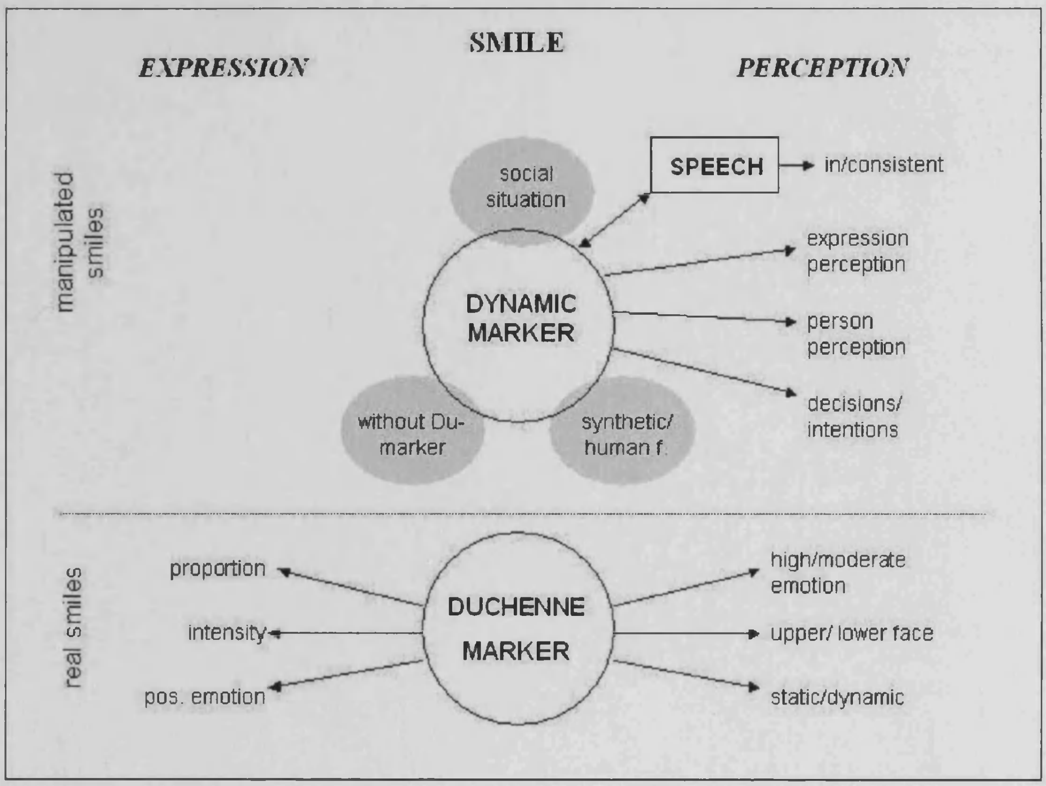

Figure 6. Integrative framework depicting the dynamic marker in comparison to the Duchenne marker as measured with respect to the expression and perception of smiles.

Implications and Contributions

The present dissertation provides empirical evidence of the effects of dynamic aspects in the perception of smile expressions. Moreover, it reports a first systematic investigation of the reliability and validity of the Duchenne marker in relation to both the expresser's behaviour and the perceiver's judgements. This combination of findings with respect to dynamic markers and the Duchenne marker extends two lines of research. Firstly, it adds to the literature on the distinction between felt and false smiles (Ekman & Friesen, 1982a; Frank & Ekman, 1993; Frank et al., 1993) by pointing to the signal value of dynamic cues in smile differentiation and by calling into question the discriminative power of the Duchenne. Secondly, it extends previous literature on the effects of dynamic information on emotion recognition (i.e., Ambadar et al., 2005; Kamachi et al., 2001), by showing that dynamic components also influence the perception and interpretation of expressions. Together these two lines of research have significant implications for understanding the role of dynamic information in smile expressions.

Focusing on the manipulation of dynamic parameters, the present dissertation extends previous research on the effects of smile expressions in specific social settings such as a simulated job interview situation (Edinger & Patterson, 1983; Forbes & Jackson, 1980; Young & Beier, 1977) and trust games (Scharlemann et al., 2001). So far, none of these studies had investigated varying forms of smiles or their impact on perceivers' impressions and decisions. The results of the present research provide initial evidence of the role of smile dynamics in these two social contexts. This has implications for research on the influence of nonverbal behaviour in the context of social situations more generally (i.e., work psychology, behavioural economics), and suggests that similar effects might be found in other social settings. It also extends our past work (Krumhuber & Kappas, 2005; Krumhuber et al., 2007) in which we studied the communicative value of dynamic aspects of smiles in the absence of social contextual information.

The findings of the present research extend beyond the effects of smile dynamics on expression and person perception, by showing that they also influence behavioural intentions and decisions and that they do so in the absence of the Duchenne marker. This provides a significant addition to our previous research (Krumhuber & Kappas, 2005; Krumhuber et al., 2007) and shows that dynamic aspects of smiling behaviour have the potential to guide consequential decisions over and above the presence of activity in the eye region. The present research can also be seen as extending previous research on thin-slice displays (e.g., Ambady & Rosenthal, 1992, 1993), by showing that temporal differences in smiling that last for just a few seconds have a measurable impact on perceivers' judgements. Until now, the effects of such subtle changes within a given type of facial behaviour (i.e., the smile) have not been explored.

The work reported in the present dissertation shows a noteworthy correspondence between synthetic and human faces with respect to the perception of dynamic aspects of smiles. These results corroborate existing research on impression effects in these two modes of presentation with respect to whole body movements (Bente et al., 2001). Importantly, they also allow the generalisation of our previous results based on the study of synthetic facial stimuli (Krumhuber & Kappas, 2005; Krumhuber et al., 2007) to the perception and judgement of real human faces. Such findings have interesting practical implications for computer scientists who are engaged in synthesising emotions in virtual humans (e.g., Cosker et al., 2005; Wallraven et al., 2005). The closer these characters come to humans, the more challenging it becomes to create emotion portrayals that are believable and convincing and that make the expresser appear trustworthy. The comparison of dynamic effects in synthetic and real facial stimuli, as in this dissertation, can be helpful in enhancing the believability and overall effectiveness of facial animations.

Facial expressions often co-occur with speech. The findings of the present research extend previous studies (e.g., Argyle et al., 1972; Bugental et al., 1970a; Mehrabian & Ferris, 1967; Mehrabian & Wiener, 1967) by showing that dynamic smile expressions (independent of the presence of other nonverbal signals) interact with consistent and inconsistent verbal messages in determining the overall impression created. This has significant implications for research on multi-channel communication, suggesting that the sole presence of smiles may be able to determine how the verbal message is interpreted. It also adds to the existing literature on the perceived function of smiles (i.e., joking or masking messages, Bugental, 1974; Bugental et al., 1970a; Ekman & Friesen, 1982a) by suggesting that the meanings of smiles vary as a function of different negative verbal statements. Interestingly, there was no overall effect of smile dynamics. This has implications for nonverbal research, which has tended to focus on the effects of (mostly static) nonverbal cues in the absence of verbal utterances. I conclude that although dynamic aspects of smiles are powerful relative to other nonverbal signals (e.g., the Duchenne marker), their influence on perceivers may be diluted when they are shown in combination with speech. This may simply be the result of attention being divided across the different channels – although the serial presentation of verbal and nonverbal information in the present research suggests that an explanation in terms of the way in which the meaning created by one channel affects the meaning ascribed to another channel might also be applicable.

Turning now to real smiles, rather than manipulated ones, the results of the present research are consistent with what has been observed in previous studies (e.g., Ekman et al., 1990; Ekman et al., 1988; Schmidt et al., 2006), namely that Duchenne smiles occur not only under spontaneous conditions, but also in contexts when people are deliberately posing expressions. These findings support Parkinson's (2005) claim that there is no direct evidence that Duchenne smiles reflect spontaneity per se. Moreover, they are consistent with the findings of Messinger, Fogel and Dickson (1999) in showing that emotional intensity and smile intensity are the prime determinants of whether a smile takes the form of a Duchenne or Non-Duchenne smile. This contributes to a fuller and more nuanced understanding of the Duchenne marker.

With respect to the decoding of smiles, this dissertation extends previous research (Frank et al., 1993; Hess & Kleck, 1994) by demonstrating that people generally not only distinguish between Duchenne and Non-Duchenne smiles, but also between the two smile types across spontaneous and deliberate elicitation conditions. Furthermore, the present results show for the first time that the emotional intensity experienced by the sender leads to a difference in the judged quality of spontaneous Duchenne smiles. This adds to the results by

Messinger et al. (1999) on the encoding of smiles, by showing that the intensity of the sender's emotion also plays an important role in smile perception. The finding that participants could distinguish between Duchenne and Non-Duchenne smiles equally well when they saw the upper or lower face is consistent with findings reported by Tremblay et al. (1993) demonstrating a limited influence of the upper face on ratings of the authenticity of smiles. This questions the notion that the Duchenne marker is an exclusively upper face feature, and calls for research on those features of the lower face that covary with the presence or absence of the Duchenne marker. In the present research participants could distinguish between spontaneous and posed smiles when they saw dynamic – but not when they saw static – displays. This finding is consistent with and goes beyond previous evidence (Ambadar et al., 2005; Wehrle et al., 2000) showing an advantage for dynamic compared to static information in the recognition of emotions in general, but not the perception of degree of spontaneity of emotions. Showing that static information not only disrupted smile differentiation, but also gave rise to incorrect judgements of smiles is to my knowledge the first evidence that static displays can mislead perceivers.

By comparing the predictive power of the Duchenne marker with that of other behavioural features, the present research makes a significant contribution to what is known about the impact of the Duchenne marker on judgements made by perceivers. Past research has not tested the communicative value of the Duchenne smile in competition with other attributes of smiles (Frank et al., 1993; Gosselin et al., 2002a, 2002b). The present results suggest that the Duchenne marker is just one of several features that perceivers use to distinguish spontaneous from deliberate expressions.

Limitations and Future Research

Although the present dissertation was successful in achieving its goals, like any research endeavour it has limitations stemming from methodological choices made in conducting the research. One of the possible limitations concerns the manipulation of dynamic aspects of smiles. Smile expressions were characterised by onset, apex and offset durations that varied within a specific time range. Although the chosen time parameters may have been sufficient to represent smiles that were more ore less authentic in their quality, further research is needed to test a larger range of durations for each dynamic component. Such research would enable investigators to identify the boundary conditions of perceived smile genuineness. That is, how long can a smile onset last and still be judged as genuine? Is there a minimum time with respect to how genuine a smile is perceived at its peak? So far, no research has identified the dynamic boundaries of genuine smile expressions, either on the encoding or on the decoding side.

The present research has shown an effect of smile dynamics on first impressions of unknown others made in a limited period of time. An interesting avenue for future research would be to test the long-term consequences of these dynamic qualities. Particularly in Chapter 3 the results showed that participants were less willing to engage in future interaction (i.e., meet outside the context of the research) when the stimulus person showed a smile that was fake in its dynamic properties. Do such effects of smile dynamics persist over time, or do they diminish or even backfire in the long run? Do participants respond differently to their counterpart's facial expressions if they anticipate future interaction? In this context, the impact of facial dynamics needs to be assessed over a longer time span and when there is a continued relationship with the stimulus person.

Another limitation of the present research stems from its focus on smile expressions. I have demonstrated the influential role played by facial dynamics only with respect to the perception of smiles. Clearly, smiles are one of the most ubiquitous and at the same time most varied facial displays (Ekman & Friesen, 1982a). Nonetheless, there is evidence suggesting that dynamic information not only has an effect on how smiles are recognised, but also on the perception of negative expressions (Ambadar et al., 2005; Kamachi et al., 2001). Further work is needed to establish whether dynamic aspects also shape perceptions and interpretations of negative facial displays. Specifically, in the context of reciprocal interactions (e.g., negotiations; Van Kleef, De Dreu, & Manstead, 2004) negative emotions such as anger or disappointment may be strategically displayed to create specific impressions and influence people's intentions without the emotion in question necessarily being felt. It would be interesting to see whether such 'intentional' (or posed) expressions have a different dynamic quality and whether they are judged by observers as less authentic than negative displays that are accompanied by the emotion in question.

A main goal of this dissertation was to study the communicative impact of facial dynamics on perception because previous decoding studies (Hess & Kleck, 1994; Hess et al., 1989) left its status unclear. Although there is good evidence of dynamic differences in spontaneous and posed smiles with respect to the encoding of smiles (Bugental, 1986; Ekman & Friesen, 1982a; Hess & Kleck, 1990, Schmidt et al., 2006; Weiss et al., 1987), more research is still needed. For example, it would be interesting to test whether facial dynamics have a modulating or even initiating role in the subjective experience of emotion. For example, do smiles with fake dynamic qualities induce less positive feelings than those with authentic dynamic qualities? Such intentional or 'managed-heart' (Hochschild, 1983) expressions could have a negative feedback on senders' emotional experience and on various physiological measures (e.g., heart rate, skin conductance). Research on facial feedback has shown that such facial efference can result in significant changes in how a sender feels about a subjective experience, even in the absence of an emotional stimulus (see Adelmann &

Zajonc, 1989, for a review). In recent years, this idea has been further developed, suggesting that facial expressions and other physical states are embodied in brain modality specific systems that link sensory-motor and affective modalities (Niedenthal, 2007; Niedenthal, Barsalou, Winkielman, Kraut-Gruber, & Ric, 2005; Winkielman, Niedenthal, & Oberman, in press). One possible topic for future research would be to test whether the dynamic properties of emotional expressions are reflected in these sensory, motor and affective systems.

With regard to the perception of facial expressions, one issue that still needs to be addressed is how aware perceivers are about the effects of facial dynamics. Do they consciously use knowledge of dynamic smile differences to guide their judgements and decisions? Based on what has been shown in past studies (Nisbett & Wilson, 1977; Hess et al., 1989; Hess & Kleck, 1994) and what I occasionally found in debriefing participants in my own research, perceivers may be less aware of what drives their behaviour than they believe themselves to be. Intriguing research by Winkielman and colleagues (Winkielman & Berridge, 2004; Winkielman, Berridge, & Wilbarger, 2005) showed that reactions to subliminally presented facial expressions influenced judgements and behavioural choices even in the absence of conscious feelings. It would therefore be worth examining whether perceivers subjectively recognise the influence of facial dynamics on their decisions.

Future research could also examine whether dynamic aspects of smiles influence responses to novel stimuli that are consistent or inconsistent in affective quality. Niedenthal (1990) showed that participants identified previously seen cartoon characters faster if those stimuli were paired with undetected slides of faces that expressed the same emotion. In a similar vein, trustworthy vs. untrustworthy looking characters might be recognised faster if those stimuli were paired with unrelated face stimuli that expressed more vs. less authentic dynamic smiles. In this sense, the dynamic properties of smiles may convey affect-consistent or affect-inconsistent qualities of trustworthiness that determines subsequent speed of target responses on discrimination tasks. Although paired face stimuli were presented in a subliminal way by Niedenthal (1990), such an effect might also happen on the conscious level. Promising evidence comes from the results in Chapter 3 in which people's decisions and intentions were mediated by inferences of perceived trustworthiness derived from facial dynamics.

To this end, it would be interesting to test the associative effects of facial dynamics of one character not only on the perception of another character, but within the same person but on peripheral, unrelated attributes. Miles and colleagues (Miles & Johnston, in press; Peace, Miles, & Johnston, 2006) showed that t-shirts of senders displaying genuine smiles (Duchenne smiles) attracted more positive evaluations than did those that were paired with posed smiles (Non-Duchenne smiles) or neutral expressions. Interestingly, this was the case even when there was no explicit goal for making preference ratings of the t-shirt in the first place, but also when they simply had to indicate the colour of the t-shirt before they were asked to rank order them in terms of how much they liked each t-shirt. An avenue for future research therefore could be to explore whether the effect of facial dynamics also spreads to peripheral factors (other than the target expression), and when making explicit (deliberative) as well as implicit (i.e., unrelated cognitive evaluations such as colour naming) judgements. This might be especially interesting when making trustworthiness judgements on the basis of dynamic smile expressions. Recent research in neuroscience suggests that the amygdala is equally involved not only in explicit but also in implicit evaluations of the trustworthiness of faces (Engell, Haxby, & Todorov, 2007; Winston et al., 2002). Winston and colleagues found increased amygdala activity in response to faces that were rated as untrustworthy when making both explicit judgements about whether an individual was trustworthy and unrelated age assessments. Interestingly, the insula was also activated, indicating that untrustworthy looking individuals may have produced emotional responses and changes in feelings in the perceiver that may then have been used as a guidance in making their judgements (Winston et al., 2002).

This influence of one's own emotional response to face stimuli on judgements made about the expresser points to the involvement of 'embodiment' in social information processing (Niedenthal, 2007; Niedenthal et al., 2005; Winkielman et al., in press). According to theories of embodied cognition, reexperiencing or simulating the relevant state in oneself is important for processing the meaning of social and emotional stimuli. A central component of this embodied simulation is the imitation or mimicry of the other individual's emotional expression. There is evidence that individuals automatically mimic other people's facial expressions and that such mimicry is involved in the process of emotion perception (see Niedenthal et al., 2005, for a review). An important question to explore then is how perceivers react to the differences between dynamic smile expressions? Do they mimic the dynamic properties of smiles in order to differentiate between them? Given that dynamic authentic smiles consist of relatively long onset and offset durations, such expressions should be easier to imitate (i.e., be more contagious; see Hatfield, Cacioppo, & Rapson, 1993), thereby allowing more empathic experiencing and role-taking (see Bavelas, Black, Lemery, & Mullett, 1987). As was suggested in Chapter 1, facial mimicry to moving faces may be important in detecting dynamic changes in facial expressions of emotions. When prevented from mimicking, Niedenthal and colleagues (2001) showed that individuals performed significantly worse in detecting a change in morphed expressions that moved into a categorically different expressions, as compared to when perceivers were allowed to mimic. Future research could examine whether the inhibition of facial mimicry in response to smile dynamics affects judgements of smile authenticity and trustworthiness. Participants might be less able to discriminate between smiles that differ in their dynamic quality when they cannot readily mimic the moving expression.

A possible avenue for future research that could also shed further light on this embodiment theory would be to study the neural underpinnings of dynamic face perception. Until now, several neuroimaging studies have shown differential neural activation in response to dynamic as compared to static facial expressions (Kilts, Egan, Gideon, Ely, & Hoffman, 2003; LaBar, Crupain, Voyvodic, & McCarthy, 2003; Sato, Kochiyama, Yoshikawa, Naito, & Matsumura, 2004). The brain areas involved in dynamic face perception were identified as particularly sensitive in detecting the intentions of a viewed subject (superior temporal sulcus; Kilts et al., 2003), and were held responsible for heightened emotional processing of dynamic expressions (amygdala; LaBar et al., 2003; Sato et al., 2004). Importantly, Sato and colleagues (2004) also showed higher activity in the ventral premotor cortex when perceiving dynamic expressions. It has been suggested that this area plays a central role in the mirror neuron system that not only becomes active when performing a task, but also when observing the same task being performed by others (i.e., when perceiving intentional behaviour; Rizzolatti, Fadiga, Fogassi, & Gallese, 2002). An interesting step for future research would therefore be to test whether this brain region shows similar activation when expressing as when observing dynamic smile expressions in social contexts. This approach might provide important new insights into parallels between emotion expression and emotion perception, and thereby contribute to theories of embodied cognition (i.e., mechanisms of imitation, correspondence between actions of the self and the other, etc.).

A further research topic could be the investigation of different neural pathways involved in the perception of authentic and fake smiles. An explanation borrowed from cognitive neuroscience relates to the motivational role of emotional expressions as social rewards or punishers. There is evidence that positive expressions (i.e., smiles) act as rewarding stimuli (O'Doherty et al., 2003), whereas negative expressions (e.g., fear) function as aversive threatening stimuli (Phan, Fitzgerald, Nathan, & Tancer, 2006; Rosen, & Donley, 2006). In future research, it could be determined whether dynamic aspects of smiles have a motivational function. Authentic dynamic smiles might act as rewarding social stimuli, whereas fake dynamic smiles might be less rewarding or even have a punishing effect. Furthermore, brain activation obtained during perceptions of these fake and authentic smiles could be used to predict subsequent judgements and decisions on the part of the perceiver.

In sum, numerous research agendas are opened up if one begins to consider the neural underpinnings of dynamic face perception. The present research represents a promising first step towards a more thorough understanding of facial dynamics and will, I hope, inspire a range of future studies on the 'temporal aspects of facial displays'.

REFERENCES

Abel, M. H. (2002). The elusive nature of smiling. In M. H. Abel (Ed.), *An empirical reflection on the smile* (pp. 1-13). New York: Edwin Mellen Press.

Adelmann, P. M., & Zajonc, R. B. (1989). Facial efference and the experience of emotion. *Annual Review of Psychology, 40*, 249-280.

Adolphs, R. (2002). Trust in the brain. *Nature Neuroscience, 5*, 192-193.

Ambadar, Z., Schooler, J. W., & Cohn, J. F. (2005). Deciphering the enigmatic face: The importance of facial dynamics in interpreting subtle facial expressions. *Psychological Science, 16*, 403-410.

Ambady, N., Bernieri, F., & Richeson, J. (2000). Toward histology of social behavior: Judgmental accuracy from thin slices of the behavioral stream. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol 32, pp 201-271). Boston: Academic Press.

Ambady, N., & Rosenthal, R. (1992). Thin slices of behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin, 2*, 256-274.

Ambady, N., & Rosenthal, R. (1993). Half a minute: Predicting teacher evaluations from thin slices of behavior and physical attractiveness. *Journal of Personality and Social Psychology, 64*, 431-441.

Argyle, M., Alkema, F., & Gilmour, R. (1972). The communication of friendly and hostile attitudes by verbal and non-verbal signals. *European Journal of Social Psychology, 1*, 385-402.

Asch, S. E. (1946). Forming impressions of personality. *Journal of Abnormal and Social Psychology, 41*, 258-290.

Bailenson, J. N., Blascovich, J., Beall, A. C., & Loomis, J. M. (2001). Equilibrium revisited: Mutual gaze and personal space in virtual environments. *Presence, 10*, 583-598.

Bassili, J. N. (1978). Facial motion in the perception of faces and of emotional expression. *Journal of Experimental Psychology: Human Perception and Performance, 4,* 373-379.

Bassili, J. N. (1979). Emotion recognition: The role of facial movement and the relative importance of upper and lower areas of the face. *Journal of Personality and Social Psychology, 37,* 2049-2058.

Bavelas, J. B., Black, A., Lemery, C. R., & Mullett, J. (1987). Motor mimicry as primitive empathy. In N. Eisenberg & J. Strayer (Eds.), *Empathy and its development. Cambridge studies in social and emotional development* (pp. 317-338). New York, NY: Cambridge University Press.

Bente, G., Krämer, N. C., Petersen, A., & de Ruiter, J. (2001). *Journal of Nonverbal Behavior, 25*, 151-166.

Biele, C., & Grabowska, A. (2006). Sex differences in perception of emotion intensity in dynamic and static facial expressions. *Experimental Brain Research, 26*, 1-6.

Blascovich, J. (2001). Social influences within immersive virtual environments. In R. Schroeder (Ed.), *The social life of avatars* (pp. 127-145). New York: Springer-Verlag.

Blens, H., Krämer, C., & Bente, G. (2003). Virtuelle Verkäufer: Die Wirkung von antromporphen Interface Agenten in WWW und e-commerce. In J. Ziegler et al. (Eds.), *Mensch und Computer 2003*. Stuttgart: Teubner.

Boone, R. T., & Buck, R. (2003). Emotional expressivity and trustworthiness: The role of nonverbal behavior in the evolution of cooperation. *Journal of Nonverbal Behavior, 27,* 163-182.

Boucher, J. D., & Ekman, P. (1975). Facial areas and emotional information. *Journal of Communication, 25*, 21-29.

Bould, E., & Morris, N. (in press). Role of motion signals in recognizing subtle facial expressions of emotion. *British Journal of Psychology*.

Bruce, V., Green, P. R., & Georgeson, M. A. (1996). *Visual perception: Physiology, Psychology, and Ecology*. Hove: Psychology Press.

Bruce, V., & Valentine, T. (1988). When a nod's as good as a wink: The role of dynamic information in facial recognition. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Ed), *Practical aspects of memory: Current research and issues, Vol. 1* (pp. 169-174). New York, NY: John Wiley & Sons.

Buck, R. (1984). *The communication of emotion*. New York: Guilford.

Bugental, D. (1974). Interpretations of naturally occurring discrepancies between words and intonation: Modes of inconsistency resolution. *Journal of Personality and Social Psychology, 30*, 125-133.

Bugental, D. B. (1986). Unmasking the "polite smile": Situational and personal determinants of managed affect in adult-child interaction. *Personality and Social Psychology Bulletin, 12*, 7-16.

Bugental, D. E., Kaswan, J. W., & Love, L. R. (1970a). Perception of contradictory meanings conveyed by verbal and nonverbal channels. *Journal of Personality and Social Psychology, 16*, 647-655.

Bugental, D. E., Kaswan, J. W., Love, L. R., & Fox, M. N. (1970b). Child versus adult perception of evaluative messages in verbal, vocal, and visual channels. *Developmental Psychology, 2*, 367-375.

BusinessWeek (2006, March 7). On-the-job video gaming. Retrieved on January 9, 2008. http://www.businessweek.com/magazine/content/06_13/b3977062.htm

Cacioppo, J. T., Petty, R. E., Losch, M. E., & Kim, H. S. (1986). Electromyographic activity over facial muscle regions can differentiate the valence and intensity of affective reactions. *Journal of Personality and Social Psychology, 50*, 260-268.

Carroll, J. M., & Russell, J. A. (1996). Do facial expressions signal specific emotions? Judging emotion from the face in context. *Journal of Personality and Social Psychology, 70*, 205-218.

Christie, F., & Bruce, V. (1998). The role of dynamic information in the recognition of unfamiliar faces. *Memory and Cognition, 26*, 780-790.

Cohn, J. F., & Schmidt, K. L. (2003). The timing of facial motion in posed and spontaneous smiles. *Proceedings of the 2nd International Conference on Active Media Technology (ICMAT 2003)* (pp. 57-72). Chongqing, China.

Cohn, J. F., & Schmidt, K. L. (2004). The timing of facial motion in posed and spontaneous smiles. *International Journal of Wavelets, Multiresolution, and Information Processing, 2*, 1-12.

Cosker, D., Paddock, S., Marshall, D., Rosin, P. L., & Rushton, S. (2005). Towards perceptually realistic talking heads: Models, methods and McGurk. *ACM Transactions on Applied Perception, 2*, 1-18.

Cosmides, L., & Tooby, J. (2005). In D. M. Buss (Ed.), *The handbook of evolutionary psychology* (pp. 584-627). Hoboken, NJ: Wiley.

De Cremer, D. (1999). Trust and fear of exploitation in a public goods dilemma. *Current Psychology, 18*, 153-163.

Dehn, D. M., & van Mulken, S. (2000). The impact of animated interface agents: a review of empirical research. *International Journal of Human-Computer Studies, 52*, 1-22.

DePaulo, B. (1992). Nonverbal behavior and self-presentation. *Psychological Bulletin, 111*, 203-243.

DePaulo, B. M., Rosenthal, R., Eisenstat, R. A., Rogers, P. L., & Finkelstein, S. (1978). Decoding discrepant nonverbal cues. *Journal of Personality and Social Psychology, 36,* 313-323.

Duchenne, B. (1862/1990). *The Mechanism of Human Facial Expression or an Electro-Physiological Analysis of the Expression of the Emotions*, A. Cuthbertson (trans.). New York: Cambridge University Press.

Edinger, J. A., & Patterson, M. L. (1983). Nonverbal involvement and social control. *Psychological Bulletin, 93*, 30-56.

Edwards, K. (1998). The face of time: Temporal cues in facial expressions of emotion. *Psychological Science, 9,* 270-276.

Ekman, P. (1982). *Emotion in the human face* (2nd ed.). Cambridge, UK: Cambridge University Press.

Ekman, P. (1984). Expression and the nature of emotion. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 319-344). Hillsdale, NJ: Erlbaum.

Ekman, P. (1985). *Telling Lies*. New York: Norton.

Ekman, P. (1989). The argument and evidence about universals in facial expressions of emotion. In H. Wagner & A. Manstead (Eds.), *Handbook of Psychophysiology: The Biological Psychology of the Emotions and Social Processes* (pp. 143-164). London: John Wiley Ltd.

Ekman, P. (1992a). An argument for basic emotions. *Cognition and Emotion, 6,* 169-200.

Ekman, P. (1992b). Are there basic emotions? *Psychological Review, 99*, 550-553.

Ekman, P. (1992c). Facial expressions of emotions: New finding, new questions. *Psychological Science, 3,* 34-38.

Ekman, P. (1993). Facial expression and emotion. *American Psychologist*, 48, 384-392.

Ekman, P. (1994). All emotions are basic. In P. Ekman & R.J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 15-19). New York: Oxford University Press.

Ekman, P., Davidson, R., & Friesen, W. V. (1990). The Duchenne smile: Emotional expression and brain physiology *II. Journal of Personality and Social Psychology, 58,* 342-353.

Ekman, P., & Friesen, W. V. (1978). *The facial action coding system.* Palo Alto, CA: Consulting Psychologists Press.

Ekman, P., & Friesen, W. V. (1982a). Felt, false and miserable smiles. *Journal of Nonverbal Behavior, 6,* 238-252.

Ekman, P., & Friesen, W. V. (1982b). Measuring facial movement with the Facial Action Coding System. In P. Ekman (Ed.), *Emotion in the human face* (2nd edition) (pp. 178-211). New York: Cambridge University Press.

Ekman, P., Friesen, W. V., & Ancoli, S. (1980a). Facial signs of emotional experience. *Journal of Personality and Social Psychology, 39,* 1125-1134.

Ekman, P., Friesen, W. V., & Ellsworth, P. (1972). *Emotion in the human face: Guidelines for research and an integration of findings.* New York: Pergamon Press.

Ekman, P., Friesen, W. V., & Ellsworth, P. (1982a). Methodological decisions. In P. Ekman (Ed.), *Emotion in the human face* (2nd ed.) (pp. 22-38). New York: Cambridge University Press.

Ekman, P., Friesen, W. V., & Ellsworth, P. (1982b). What are the relative contributions of facial behavior and contextual information to the judgment of emotion? In P. Ekman (Ed.), *Emotion in the human face* (2nd ed., pp. 111-127). Cambridge: Cambridge University Press.

Ekman, P., Friesen, W. V., & Hager, J. C. (2002). *The facial action coding system* (2nd ed.). Salt Lake City, UT: Research Nexus eBook.

Ekman, P., Friesen, W. V., & O'Sullivan, M. (1988). Smiles when lying. *Journal of Personality and Social Psychology, 54*, 414-420.

Ekman, P., Hager, J. C., & Friesen, W. V. (1981). The symmetry of emotional and deliberate facial actions. *Psychophysiology, 18,* 101-106.

Ekman, P., Roper, G., & Hager, J. C. (1980b). Deliberate facial movement. *Child Development, 51,* 886-891.

Engell, A. D., Haxby, J. V., & Todorov, A. (2007). Implicit trustworthiness decisions: Automatic coding of face properties in human amygdala. *Journal of Cognitive Neuroscience, 19*, 1508-1519.

Fernández-Dols, J. M., & Carroll, J. M. (1997). Is the meaning perceived in facial expression independent of its context? In J. A. Russell, & J. M. Fernandez-Dols (Eds.), *The psychology of facial expression* (pp. 275-294). Cambridge, UK: Cambridge University Press.

Fernández-Dols, J. M., & Ruiz-Belda, M. A. (1995). Are smiles a sign of happiness? Gold medal winners at the Olympic games. *Journal of Personality and Social Psychology, 69,* 1113-1119.

Fernández-Dols, J. M., & Ruiz-Belda, M. A. (1997). Spontaneous facial behaviour during intense emotional episodes: Artistic truth and optical truth. In J. A. Russell & J. M. Fernández-Dols (Eds.), *The psychology of facial expression* (pp. 255-274). New York/Paris: Cambridge University Press/Editions de la Maison des Sciences de l'Homme.

Forbes, R. J., & Jackson, P. R. (1980). Non-verbal behavior and the outcome of selection interviews. *Journal of Occupational Psychology, 53,* 65-72.

Forgas, J. P. (1985). *Interpersonal behaviour: The psychology of social interaction.* Sydney, Oxford, New York: Pergamon Press.

Frank, R. H. (1988). *Passions within reason*. New York: W. W. Norton.

Frank, R. H. (2004). Introducing moral emotions into models of rational choice. In A. S. R. Manstead, N. Frijda, & A. Fischer (Eds.) (pp. 422-440), *Feelings and Emotions*. New York: Cambridge University Press.

Frank, M. G., & Ekman, P. (1993). Not all smiles are created equal: the differences between enjoyment and nonenjoyment smiles. *Humor: International Journal of Humor Research, 6,* 9-26.

Frank, M. G., Ekman, P. & Friesen, W. V. (1993). Behavioral markers and recognizability of the smile of enjoyment. *Journal of Personality and Social Psychology, 64*, 83-93.

Frijda, N. H. (1969). Recognition of emotion. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 4, pp. 167-223). New York: Academic Press.

Frijda, N. H. (1986). *The emotions*. Cambridge: Cambridge University Press.

Funder, D. C. (1995). On the accuracy of personality judgment: A realistic approach. *Psychological Review, 102*, 652-670.

Gepner, B., Deruelle, C., Grynfeltt, S. (2001). Motion and emotion: A novel approach to the study of face processing by young autistic children. *Journal of Autism and Developmental Disorders, 31*, 37-45.

Gosselin, P., Beaupré, M., & Boissonneault, A. (2002a). Perception of genuine and masking smiles in children and adults: Sensitivity to traces of anger. *The Journal of Genetic Psychology, 163*, 58-71.

Gosselin, P., Perron, M., Legault, M., & Campanella, P. (2002b). Children's and adults' knowledge of the distinction between enjoyment and nonenjoyment smiles. *Journal of Nonverbal Behavior, 26*, 83-108.

Hager, J. C. & Ekman, P. (1997). The asymmetry of facial actions is inconsistent with models of hemispheric specialization. In P. Ekman & E. Rosenberg (Eds.), *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System (FACS)* (pp. 40-62). New York: Oxford University Press.

Harwood, N. K., Hall, L. J., & Shinkfield, A. J. (1999). Recognition of facial emotional expressions from moving and static displays by individuals with mental retardation. *American Journal of Mental Retardation, 104*, 270-278.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1993). Emotional contagion. *Current Directions in Psychological Science, 2,* 96-99.

Hess, U. (2001). The communication of emotion. In A. Kaszniak (Ed.), *Emotions, qualia and consciousness* (pp. 397-409). Singapore: World Scientific Publishing.

Hess, U., Adams, R. B., & Kleck, R. E. (2005). Who may frown and who should smile? Dominance, affiliation, and the display of happiness and anger. *Cognition and Emotion, 19*, 515-536.

Hess, U., Blairy, S., & Kleck, R. E. (1998). The relationship between the intensity of emotional facial expressions and observers' decoding. *Journal of Nonverbal Behavior, 21*, 241-257.

Hess, U., Blairy, S., & Kleck, R. E. (2000). The influence of facial emotion displays, gender, and ethnicity on judgments of dominance and affiliation. *Journal of Nonverbal Behavior, 24*, 265-283.

Hess, U., Kappas, A., & Scherer, K. R. (1988). Multichannel communication of emotion: Synthetic signal production. In K. R. Scherer (Ed.), *Facets of emotion: Recent research* (pp. 161-182). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hess, U., Kappas, A., McHugo, G. J., Kleck, R. E., & Lanzetta, J. T. (1989). An analysis of the encoding and decoding of spontaneous and posed smiles: The use of facial electromyography. *Journal of Nonverbal Behavior, 13,* 121-137.

Hess, U., & Kleck, R. E. (1990). Differentiating emotion elicited and deliberate emotional facial expressions. *European Journal of Social Psychology, 20,* 369-385.

Hess, U., & Kleck, R. E. (1994). The cues decoders use in attempting to differentiate emotion-elicited and posed facial expressions. *European Journal of Social Psychology, 24,* 367-381.

Hill, H., & Johnston, A. (2001). Categorizing sex and identity from the biological motion of faces. *Current Biology, 11*, 880-885.

Hochschild, A. R. (1983). *The managed heart. The commercialization of human feeling.* Berkeley, CA: University of California Press.

Imada, A. S., & Hakel, M. D. (1977). Influence of nonverbal communication and rater proximity on impressions and decisions in simulated employment interviews. *Journal of Applied Psychology, 62,* 295-300.

Jakobs, E., Manstead, A. S. R., & Fischer, A. (1999). Social motives and emotional feelings as determinants of facial displays: The case of smiling. *Personality and Social Psychology Bulletin, 25*, 424-435.

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception and Psychophysics, 14*, 201-211.

Johansson, G. (1976). Spatio-temporal differentiation and integration in visual motion perception. *Psychological Research, 38*, 379-393.

Kamachi, M., Bruce, V., Mukaida, S., Gyoba, J., Yoshikawa, S., & Akamatsu, S. (2001). Dynamic properties influence the perception of facial expressions. *Perception, 30*, 875-887.

Kappas, A. (1997). The fascination with faces: Are they windows to our soul? *Journal of Nonverbal Behavior, 21,* 157-161.

Kappas, A. (2003). What facial activity can and cannot tell us about emotions. In M. Katsikitis (Ed.), *The human face: Measurement and meaning* (pp. 215-234). Dordrecht: Kluwer Academic Publishers.

Kelley, H. H. (1950). The warm-cold variable in first impressions of persons. *Journal of Personality, 18,* 431-439.

Keltner, D., & Haidt, J. (1999). Social functions of emotions at four levels of analysis. *Cognition and Emotion, 13,* 505-521.

Kerlow, I. V. (2004). *The art of 3D computer animation and effects* (3rd edition). New Jersey: John Wiley & Sons.

Kerstenbaum, R. (1992). Feeling happy versus feeling good: The processing of discrete and global categories of emotional expressions by children and adults. *Developmental Psychology, 28,* 1132-1142.

Kilts, C. D., Egan, G., Gideon, D. A., Ely, T. D., & Hoffman, J. M. (2003). Dissociable neural pathways are involved in the recognition of emotion in static and dynamic facial expressions. *Neuroimage, 18,* 158-168.

Knappmeyer, B., Thornton, I. A., & Bülthoff, H. H. (2003). The use of facial motion and facial form during the processing of identity. *Vision Research, 43,* 1921-1936.

Knight, B., & Johnston, A. (1997). The role of movement in face recognition. *Visual Cognition, 4,* 265-273.

Koda, T., & Maes, P. (1996). Agents with faces: The effects of personification of agents. *Proceedings of the 5th IEEE International Workshop on Robot and Human Communication (RO-MAN'96),* pp. 189-194.

Krämer, N. C., Tietz, B., & Bente, G. (2003). Effects of embodied interface agents and their gestural activity. In R. Aylett, D. Ballin, T. Rist, & J. Rickel (Eds.), *4th International Working Conference on Intelligent Virtual Agents*. Hamburg: Springer.

Kraut, R.E., & Johnston, R.E. (1979). Social and emotional messages of smiling: An ethological approach. *Journal of Personality and Social Psychology, 37,* 1539-1553.

Krumhuber, E., & Kappas, A. (2005). Moving smiles: The role of dynamic components for the perception of the genuineness of smiles. *Journal of Nonverbal Behavior, 29,* 3-24.

Krumhuber, E., Manstead, A. S. R, & Kappas, A. (2007). Temporal aspects of facial displays in person and expression perception. The effects of smile dynamics, head-tilt and gender. *Journal of Nonverbal Behavior, 31*, 39-56.

Krumhuber, E., Manstead, A. S. R., Cosker, D., Marshall, D., Rosin, P. L., & Kappas, A. (in press). Facial dynamics as indicators of trustworthiness and cooperative behavior. *Emotion.*

LaBar, K. S., Crupain, M. J., Voyvodic, J. T., & McCarthy, G. (2003). Dynamic perception of facial affect and identity in the human brain. *Cerebral Cortex, 13*, 1023-1033.

Lander, K., & Bruce, V. (2004). Repetition priming from moving faces. *Memory and Cognition, 32*, 640-647.

Lander, K., Christie, F., & Bruce, V. (1999). The role of movement in the recognition of famous faces. *Memory and Cognition, 27*, 974-985.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2001). *International Affective Picture System (IAPS): Instruction manual and affective ratings* (Technical report A-5). Gainsville, FL: The Center for Research in Psychophysiology, University of Florida.

Lederman, S. J., Klatzky, R. L., Abramowicz, A., Salsman, K., Kitada, R., & Hamilton, C. (2007). Haptic recognition of static and dynamic expressions of emotion in the life face. *Psychological Science, 18*, 158-164.

Lee, V., & Beattie, G. (1998). The rhetorical organisation of verbal and nonverbal behaviour in emotion talk. *Semiotica, 120*, 39-92.

Leonard, C. M., Voeller, K. K, & Kuldau, J. M (1991). When's a smile a smile? or How to detect a message by digitizing the signal. *Psychological-Science, 2,* 166-172.

Mehrabian, A. (1970). When are feelings communicated inconsistently? *Journal of Experimental Research in Personality, 4,* 198-212.

Mehrabian, A., & Ferris, S. R. (1967). Inference of attitudes from nonverbal communication in two channels. *Journal of Consulting Psychology, 31*, 248-252.

Mehrabian, A., & Wiener, M. (1967). Decoding of inconsistent communications. *Journal of Personality and Social Psychology, 6,* 109-114.

Messinger, D. S. (2002). Positive and negative: Infant facial expressions and emotions. *Current Directions in Psychological Science, 11*, 1-6.

Messinger, D. S., Fogel, A., & Dickson, K. L. (1999). What's in a smile? *Developmental Psychology, 35*, 701-708.

Miles, L., & Johnston, L. (in press). Not all smiles are created equal: Perceiver sensitivity to the differences between posed and genuine smiles. In. G. Haberman & C. Flethcher-Flinn (Eds.), *Cognition and language: Perspectives from New Zealand.* Bowen Hills (Queensland, Australia): Australian Academic Press.

Miller, J. (1983). *States of mind.* New York: Pantheon Books.

Niedenthal, P. M. (1990). Implicit perception of affective information. *Journal of Experimental Social Psychology, 26*, 505-527.

Niedenthal, P. M. (2007). Embodying emotion. *Science, 316*, 1002-1005.

Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Kraut-Gruber,S., & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review, 9*, 184-211.

Niedenthal, P. M., Brauer, M., Halberstadt, J. B., & Innes-Ker, Å. H. (2001). When did her smile drop? Facial mimicry and the influence of emotional state on the detection of change in emotional expression. *Cognition and Emotion, 15*, 853-864.

Niedenthal, P. M., Halberstadt, J. B., Margolin, J., & Innes-Ker, Å. H. (2000). Emotional state and the detection of change in facial expression of emotion. *European Journal of Social Psychology, 30*, 211-222.

Nisbett, R., & Wilson, T. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84,* 231-259.

O'Doherty, J. O., Winston, J., Critchley, H., Perrett, D., Burt, D. M., & Dolan, R. J. (2003). Beauty in a smile: The role of medial orbitofrontal cortex in facial attractiveness. *Neuropsychologia, 41*, 147-155.

O'Toole, A. J., Roark, D. A., & Abdi, H. (2002). Recognizing moving faces: A psychological and neural synthesis. *Trends in Cognitive Sciences, 6*, 261-266.

Parkinson, B. (2005). Do facial movements express emotions or communicate motives? *Personality and Social Psychology Review, 9*, 278-311.

Peace, V., Miles, L., & Johnston, L. (2006). It does't matter what you wear: the impact of posed and genuine expressions of happiness on product evaluation. *Social Cognition, 24*, 137-168.

Phan, K. L., Fitzgerald, D. A., Nathan, P.-J., & Tancer, M. E. (2006). Association between amygdala hyperactivity to harsh faces and severity of social anxiety in generalized social phobia. *Biological Psychiatry, 59*, 424-429.

Pike, G. E., Kemp, R. I., Towell, N. A., & Phillips, K. C. (1997). Recognizing moving faces: The relative contribution of motion and perspective view information. *Visual Cognition, 4*, 409-437.

Pizzamiglio, L., Caltagirone, C., & Zoccolotti, P. (1989). Facial expression of emotion. In F. Boller & J. Grafman (Eds.), *Handbook of Neuropsychology* (pp. 383-401). New York: Elsevier Science.

Rasmussen, K. G. (1984). Nonverbal behavior, verbal behavior, resumé credentials, and selection interview outcomes. *Journal of Applied Psychology, 69*, 551-556.

Reade, M. N., & Smouse, A. D. (1980). Effect of inconsistent verbal-nonverbal communication and counselor response mode on client estimate of counselor regard and effectiveness. *Journal of Counseling Psychology, 27*, 546-553.

Reisenzein, R., Boerdgen, S., Holtbernd, T., & Matz, D. (2006). Evidence for strong dissociation between emotion and facial displays. The case of surprise. *Journal of Personality and Social Psychology, 91*, 295-315.

Riggio, R. E., & Throckmorton, B. (1988). The relative effects of verbal and nonverbal behavior, appearance, and social skills on evaluations made in hiring interviews. *Journal of Applied Social Psychology, 18*, 331-348.

Rinn, W. E. (1991). Neuropsychology of facial expression. In R. S. Feldmann & B. Rimé (Eds.), *Fundamentals of nonverbal behavior* (pp. 3-30). Cambridge and Paris: Cambridge University Press/Editions de la Maison des Science de 1'Homme.

Rizzolatti, G., Fadiga, L., Fogassi, L., & Gallese, V. (2002). From mirror neurons to imitation: Facts and speculations. In A. N. Meltzoff & W. Prinz (Eds.), *The imitative mind: Development, evolution, and brain bases* (pp. 247-266). New York: Cambridge University Press.

Rosen, J. B., & Donley, M. P. (2006). Animal studies of amygdala function in fear and uncertainty: Relevance to human research. *Biological Psychology, 73*, 49-60.

Ross, W., & LaCroix, J. (1996). Multiple meanings of trust in negotiation theory and research: A literature review and integrative model. *International Journal of Conflict Management, 7*, 314-360.

Ruiz-Belda, M. A., Fernández-Dols, J. M., Carrera, P., & Barchard, K. (2003). Spontaneous facial expressions of happy bowlers and soccer fans. *Cognition and Emotion, 17*, 315-326.

Russell, J. A., Bachorowski, J. A., & Fernández-Dols, J. M. (2003). Facial and vocal expressions of emotion. *Annual Review of Psychology, 54*, 329-349.

Sato, W., & Yoshikawa, S. (2004). The dynamic aspects of emotional facial expressions. *Cognition and Emotion, 18*, 701-710.

Sato, W., & Yoshikawa, S. (2007a). Spontaneous facial mimicry in response to dynamic facial expressions. *Cognition, 104*, 1-18.

Sato, W., & Yoshikawa, S. (2007b). Enhanced experience of emotional arousal in response to dynamic facial expressions. *Journal of Nonverbal Behavior, 31*, 119-135.

Sato, W., Kochiyama, T., Yoshikawa, S., Naito, E., & Matsumura, M. (2004). Enhanced neural activity in response to dynamic facial expressions of emotion: an fMRI study. *Cognitive Brain Research, 20*, 81-91.

Scharlemann, J. P. W., Eckel, C. C., Kacelnik, A., & Wilson, R. K. (2001). The value of a smile: Game theory with a human face. *Journal of Economic Psychology, 22*, 617-640.

Schmidt, K. L., Ambadar, Z., Cohn, J. F., & Reed, L. I. (2006). Movement differences between deliberate and spontaneous facial expressions: Zygomaticus major action in smiling. *Journal of Nonverbal Behavior, 30*, 37-52.

Schmidt, K. L., & Cohn, J. F. (2001). Dynamics of facial expression: Normative characteristics and individual differences. *Proceedings of the International Conference on Multimedia and Expo* (pp. 728-731). Tokyo, Japan.

Schmidt, K. L., Cohn, J. F., & Tian, Y. (2003). Signal characteristics of spontaneous facial expressions: automatic movement in solitary and social smiles. *Biological Psychology, 65*, 49-66.

Schneider, K., & Josephs, I. (1991). The expressive and communicative functions of preschool children's smiles in an achievement situation. *Journal of Nonverbal Behavior, 15,* 185-198.

Shrout, P. E. & Fiske, D. W. (1981). Nonverbal behaviors and social evaluation. *Journal of Personality, 49,* 115-128.

Sobel, M. E. (1982). Asymptotic intervals for indirect effects in structural equation models. In S. Leinhart (Ed.), *Sociological methodology* (pp. 290-312). San Francisco: Jossey-Bass.

Surakka, V., & Hietanen, J. K. (1998). Facial and emotional reactions to Duchenne and non-Duchenne smiles. *International Journal of Psychophysiology, 29*, 23-33.

Takács, B., & Kiss, B. (2003). The virtual human interface: A photorealistic digital human. *IEEE Computer Graphics and Applications, 23*, 38-45.

Thornton, I. M., & Kourtzi, Z. (2002). A matching advantage for dynamic human faces. *Perception, 31*, 113-132.

Todorov, A., Mandisodza, A. N.,. Goren, A., & Hall, C. C. (2005). *Science, 308*, 1623–1626.

Tremblay, A., Deschenes, J., Poulin, B., Roy, J., Kirouac, G., & Kappas, A. (1993). Identification de régions faciales critiques dans le jugement d'authenticité d'un sourire d'expressions de joie véritablement ressentie [Identification of critical facial regions in the judgment of the genuineness of smiles expressing experienced joy]. Presented at the *XViéme Congrés annuel de la Société Québécoise pour la Recherche en Psychologie*, Québec, Canada.

Tyson, J. A., & Wall, S. M. (1983). Effect of inconsistency between counselor verbal and nonverbal behavior on perceptions of counselor attributes. *Journal of Counseling Psychology, 30*, 433-437.

Van Kleef, G. A., De Dreu, C. K., & Manstead, A. S. R. (2004). The interpersonal effects of anger and happiness in negotiations. *Journal of Personality and Social Psychology, 86*, 57-76.

Wagner, H., & Lee, V. (1999). Facial behavior alone and in the presence of others. In P. Philippot, R. S. Feldman, & E. J. Coats (Eds.), *The social context of nonverbal behavior* (pp. 262-286). Cambridge: Cambridge University Press.

Wallbott. H. G. (1988). Faces in context: The relative importance of facial expression and context information in determining emotion attributions. In K. R. Scherer (Ed.), *Facets of emotion: Recent research* (pp. 139-160). Hillsdale, NJ: Lawrence Erlbaum Associates.

Wallraven, C., Breidt, M., Cunningham, D. W., & Bülthoff, H. H. (2005). Psychophysical evaluation of animated facial expressions. *Proceedings of the 2nd Symposium on Applied Perception in Graphics and Visualization*. (pp 17-24). ACM Press: New York, NY, USA.

Wehrle, T., Kaiser, S., Schmidt, S., & Scherer, K. R. (2000). Studying the dynamics of emotional expression using synthesized facial muscle movements. *Journal of Personality and Social Psychology, 78*, 105-119.

Weiss, F., Blum, G.S., & Gleberman, L. (1987). Anatomically based measurement of facial expression in simulated versus hypnotically induced affect. *Motivation and Emotion, 11*, 67-81.

Weyers, P., Mühlberger, A., Hefele, C., & Pauli, P. (2006). Electromyographic responses to static and dynamic avatar emotional facial expressions. *Psychophysiology, 43*, 1-4.

Wiberg, C. & Wiberg, M. (2001). Configuring social agents. In *Proceedings of Conference of Universal Accessibility in Human Computer Interaction*, New Orleans.

Williams, L. M., Senior, C., David, A. S., Loughland, C. M., & Gordon, E. (2001). In search of the "Duchenne smile": Evidence from eye movements. *Journal of Psychophysiology, 15,* 122-127.

Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *Psychological Science, 17*, 592-598.

Winkielman, P., & Berridge, K. C. (2004). Unconscious emotion. *Current Directions in Psychological Science, 13*, 120-123.

Winkielman, P., Berridge, K. C., & Wilbarger, J. (2005). Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value. *Personality and Social Psychology Bulletin, 1*, 121-135.

Winkielman, P., Niedenthal, P. M., & Oberman, L. (in press). The embodied emotional mind. In G. R. Semin, & E. R. Smith (Eds.), *Embodied grounding: Social, cognitive, affective, and neuroscientific approaches*. New York: Cambridge University Press.

Winston, J. S., Strange, B. A., O'Doherty, J., & Dolan, R. J. (2002). Automatic and intentional brain responses during the evaluation of trustworthiness of faces. *Nature Neuroscience, 5*, 277-283.

Young, D. M., & Beier, E. G. (1977). The role of applicant nonverbal communication in the employment interview. *Journal of Employment Counseling, 14*, 154-165.

Zaalberg, R., Manstead, A. S. R., & Fischer, A. H. (2002). Facial behavior in game-playing situations: The mediating role of display rules and social motives. Paper presented as part of symposium "Emotion in Social Context" (convenors: Tony Manstead and Agneta Fischer) at *General Meeting of the European Association of Experimental Social Psychology*, San Sebastian, Basque Country, June 25-30.

Zaalberg, R., Manstead, A. S. R., & Fischer, A. H. (2004). Relations between emotions, display rules, social motives and facial behavior. *Cognition and Emotion, 18*, 183-207.

Zuckerman, M., DePaulo, B. M., & Rosenthal, R. (1981). Verbal and nonverbal communication of deception. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (Vol. 14, pp. 1-59). New York: Academic Press.

Zuckerman, M., Spiegel, N. H., DePaulo, B. M., & Rosenthal, R. (1982). Nonverbal strategies for decoding deception. *Journal of Nonverbal Behavior, 6*, 171-187.