



Signal characteristics of spontaneous facial expressions: automatic movement in solitary and social smiles

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Abstract

The assumption that the smile is an evolved facial display suggests that there may be universal features of smiling in addition to the basic facial configuration. We show that smiles include not only a stable configuration of features, but also temporally consistent movement patterns. In spontaneous smiles from two social contexts, duration of lip corner movement during the onset phase was independent of social context and the presence of other facial movements, including dampening. These additional movements produced variation in both peak and offset duration. Both onsets and offsets had dynamic properties similar to automatically controlled movements, with a consistent relation between maximum velocity and amplitude of lip corner movement in smiles from two distinct contexts. Despite the effects of individual and social factors on facial expression timing overall, consistency in onset and offset phases suggests that portions of the smile display are relatively stereotyped and may be automatically produced.

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Facial expression researchers have stressed the role of facial expressions as signals, both of emotion and social intention (Ekman, 1992; Fridlund, 1994; Grammer et al., 1988; Schmidt and Cohn, 2001a). Smiles are one of the most important of human facial displays, appearing early in development, and frequently throughout the lifespan, in both solitary

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and social situations (Bavelas and Chovil, 1997; Cohn and Tronick, 1983; Messinger et al., 1999; Owren and Bachorowski, 2001; Schmidt and Cohn, 2001b).

The literature describes a diversity of smiling patterns, and an exact description of what specific actions constitute the smile signal is unclear. Given the variation in appearance and temporal parameters of spontaneous smiles, it is necessary to define more clearly the portion or portions of a smile display that can be considered the primary signaling behavior, if the signaling role of smiling is to be investigated. The facial appearance of the smile with upturned lip corners as a result of *Zygomaticus major* activity, has been demonstrated to be a universal facial expression of joy across cultures (Ekman and Keltner, 1997). Ekman describes this emotional expression as “unbidden, quick, and short in duration” (Ekman, 1992). In contrast, reports of variable smiling displays including other associated movements emphasize variation in duration and onset and offset phases (Cheyne, 1976; Jones, 1984; Messinger et al., 1999; Otta et al., 1996). In the present study, we hypothesized that a particular portion of the smile display, the smile onset, has highly consistent signaling characteristics. We demonstrated the consistency of *Zygomaticus major* activity in smile onsets originating from different contexts and we also found that offset phase, as well as the onset phase of smiles, showed consistent signaling characteristics.

Fridlund (1994) has advanced a behavioral ecological interpretation of facial expression and has argued for a central signaling role of smiles. If smiles are to be considered evolved social signals, however, it is expected that they will meet several criteria widely described in behavioral ecological descriptions of animal signaling (Schmidt and Cohn, 2001b). Evolved signaling displays are the result of selective pressures for conspicuous, stereotyped, and redundant communication (Hauser, 1996; Johnstone, 1997). These characteristics ensure the efficiency of the signal in communicating among members of a species. Stereotypy, for example, provides a reliable signal that is easily recognized across individuals and contexts, while redundancy and conspicuousness increase the likelihood of signal detection by intended recipients. These features have already been observed in the configuration of human smile displays. For example, stereotypy of facial configuration has been observed in the typical facial expressions of joy appearing across individuals and across cultures, (Ekman 1993).

In this study, we initially proposed that temporal patterning of movement in the onset of spontaneous smiles constitutes a characteristic signal within the human smile display. The smile onset provides the initial and most conspicuous change in appearance of the face as perceived by human observers (Leonard et al., 1991). In a study of response to facial expressions, viewers activated their own *Zygomaticus major* muscles as early as 0.30–0.40 s after viewing an image of a smile (Dimberg and Thunberg, 1998). These results suggest that observers have a propensity to respond rapidly to facial expressions. In spontaneous social contexts, this rapid reaction is most likely in response to the onset of expressions, rather than other phases of the display, since spontaneous smiles typically last for at an average of at least 3–4 s (Frank et al., 1993) and smile onsets have been reported to last at least 0.7 s on average (Bugental, 1986). For the purposes of producing a response in a receiver’s facial muscles, therefore, the onset of expression seems likely to constitute an important facial signal. In addition, stereotypy is evident in that the upturned lip corners are found in all smile onsets (Ekman, 1993). As a display, smiling is also redundant (Bavelas and Chovil, 1997) with as many as three smiles per min, on average, occurring in social interaction (Schmidt

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