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Abstract

The consequences of social interaction can be variable, sometimes harmful, but often rewarding. The adaptive social perceiver must therefore determine which interactions are worthwhile pursuing and which are not. The present research investigated whether subtle but meaningful differences in facial expressions are perceived in terms of the affordance of approachability. Participants engaged in simulated social encounters with targets displaying enjoyment smiles, non-enjoyment smiles or neutral expressions while fluctuations in their posture were measured. The results indicated systematic differences in perceived approachability as a function of facial expression and target sex. These findings are discussed in terms of the functional coupling between social perception and action with respect to the information that specifies the affordance of approachability.

Social interaction offers essential opportunities to communicate, share resources, and cooperate, but simultaneously may be costly if an interaction turns out to be exploitative or harmful. Consequently, successful navigation within the social world necessitates selectively pursuing some interactions but not others, thereby requiring the social perceiver to determine who is approachable and who is not. What then specifies the approachability of others? The present research seeks to address this question by examining positive emotional expressions as one source of information about others which may factor prominently in perceptions of approachability.

Approachability as an affordance

Gibson's (1979) notion of affordances as opportunities for action, or in the social domain opportunities for interaction, provides a valuable framework for understanding the link between perceptual information and the initiation of social interaction. Opportunities to approach a conspecific may be perceivable to the extent that dispositional properties that invite interaction (e.g., emotions, goals, intentions) are evident in appearance or behavior (e.g., posture, facial expression, tone of voice). Further, the tight coupling between perception and action systems suggests that the perception of an affordance may entail commensurate actions. Support for this view can be found in the action priming literature; merely perceiving an object facilitates actions consistent with the affordances of that object (e.g., Tucker & Ellis, 1998). Similarly, very brief exposure to social group information facilitates behavior relevant to interacting with members of that group (Cesario, Plaks & Higgins, 2006). In this sense, perceiving information specifying approachability may be accompanied by actions that support approach behavior.

Research concerning behavior that serves the fundamental motivation to approach the aspects of the environment that offer benefit but withdraw from those which may be harmful (Schneirla, 1959) has featured prominently in the literature. In a characteristic experimental scenario, approach (e.g., arm flexion or pulling) and withdrawal (e.g., arm extension or pushing) related actions facilitate identification of positive and negative information, respectively. This effect has been shown across various classes of stimuli, including valenced words (e.g., Solarz, 1960), images (e.g., Duckworth, Bargh, Garcia & Chaiken, 2002) and more recently emotional faces. For instance, Rotteveel and Phaf (2004) demonstrated that perceiving happy or angry expressions facilitated flexion or extension. The present research extended this line of investigation by considering differences in approach behavior as a function of perceiving meaningful physiognomic variations within positive facial expressions (i.e., smiles). Importantly, as smiles are typically considered to be positive displays (Ekman, 2003) this focus provided an avenue to consider approachability beyond binary distinctions in the valence of stimulus information, and instead identify the action opportunities specific to particular forms of this expression.

In addition, the present study research employed a novel technique to assess approach related action. Research concerning approach behavior has typically postulated a mapping between the evaluation of stimulus information and the execution of specific motor actions such as flexion or extension (Elliot & Covington, 2001). However, recent reports suggest that it is not specific behaviours per se that index approach or withdrawal, rather it is the goal-relevant outcomes of actions (Maxwell & Davidson, 2007). Changing the locus of the self (Markman & Brendl, 2005), varying the instruction set given to participants (Seibt, Neumann, Nussinson & Strack, 2008), or

manipulating contextual factors (Bamford & Ward, 2008) can reverse the flexion-as-approach, extension-as-withdrawal pattern. These results dictate a more functional interpretation whereby actions that result in decreased distance between an actor and an object, or in social contexts an interaction partner, are considered to support approach, while those that result in increased distance are considered to support withdrawal (Schneirla, 1959). Accordingly, in the present study, changes in interpersonal distance during a simulated social encounter served as an index of approach behavior and, more generally, perceived approachability.

The present research

Smiles have been proposed as a means to establish and maintain effective interpersonal interactions by way of signalling trustworthiness and cooperative intent (Owren & Bachorowski, 2001). Expressions of positive emotion may also signal a safe environment or an invitation to approach. Infants tend to cross a visual cliff towards their mother when she is smiling but not when she is frowning (Sorce, Emde, Campos & Klinnert, 1985). It may be the case, therefore, that in social situations, a smiling individual is perceived as approachable in that their facial expression signals an opportunity for a safe and possibly fruitful interaction.

However, in addition to expressing positive emotion, smiles serve a diverse range of communicative functions, including acting as a means to mask other emotional experiences (Bugnetal, 1986; Ekman, 2003). The smiling individual may not, therefore, always be safe to approach, especially if their expression hides malevolent intent, for example, when angry or intending to deceive. Fortunately for the perceiver, well documented physiognomic distinctions exist between spontaneous enjoyment

smiles associated with positive emotional experience, and deliberately posed non-enjoyment smiles typically unrelated to positive emotion (see Frank, 2002 for an overview). Although previous research has shown that perceivers can be sensitive to these distinctions (e.g., Frank, Ekman & Friesen, 1993; Miles & Johnston, 2007; Surakka & Hietanen, 1998), the behavioral outcomes of such sensitivity has received little empirical attention. It may be the case that in the attentionally demanding world of social interaction all smiles are simply treated as generic positive expressions. On the other hand, the highly adaptive nature of social perception deems this unlikely, instead suggesting that to maintain the functionality that accurate perception brings, the social perceiver ought to differentiate between the affordances of those displaying enjoyment and non-enjoyment smiles. In this sense, it is anticipated that only enjoyment smiles specify approachability as only these expressions candidly advertise an individual experiencing positive emotion and the associated affordances. By comparison, non-enjoyment smiles are ambiguous in that they do not uniformly relate to any specific interaction relevant properties and therefore potentially lack utility when perceiving opportunities for interaction.

In the current investigation approachability was operationalized by monitoring interpersonal distance during a simulated social encounter. Participants viewed photographs of faces that were enlarged over time to simulate the pattern of optical expansion that specifies a looming object (Gibson, 1979), or in this case an approaching individual, while changes in their posture (indexed by head position; Stoffregen, Smart, Bardy & Pagulayan, 1999) were tracked. In this way, postural adjustments in the anterior-posterior plane served as an on-line measure of the distance between the perceiver and the (simulated) approaching individual, and

provided a means to compare perceptions of approachability as a function of differences in the target's facial expression.

Method

Participants

Forty (21 female)[1] participants with normal or corrected-to-normal vision and ranging in age from 18 to 31 years took part in exchange for NZ$15. Participants were initially informed that the study was concerned with the effects of movement on memory for faces, but were debriefed as to its actual purpose upon completion of their participation. The project was reviewed and approved by the University of Canterbury Human Ethics Committee.

Materials

Facial displays used in previous research concerning the perception of smiles were employed in the present study (for details regarding generation and coding of the expressions see Miles & Johnston, 2007). A neutral expression, a deliberately posed non-enjoyment smile and a spontaneous enjoyment smile from each of 6 target individuals (3 female) were used, making for 18 expressions in total. Inter-pupil distance was standardised across all expressions and order of facial expression presentation was randomised.

Procedure

[1] Initial analyses revealed no effects of participant sex ($F < 0.1$), hence this factor was not included in the main analysis.

Participants were tested individually in a semi-immersive virtual environment[2] consisting of three 3.1 m (w) x 2.5 m (h) rear-projected screens arranged so as to surround the participant on three sides. Participants were instructed to stand comfortably at a designated point 170 cm from the centre screen and to wear a set of clear glasses with reflective markers attached to the top outer edges of the frame. The position of these markers was tracked at a sampling rate of 40 Hz using a 4-camera infra-red tracking system mounted on the top of the screens. Two cameras were behind, and two were in front of the participant.

Each trial began with a facial display presented in the centre of the participant's field-of-view, on a background of black and white vertical stripes. Participants clicked a hand-held wireless controller to initiate the trial, whereby the facial display was enlarged to simulate the optical expansion specifying an approaching individual. Each face was enlarged at a constant linear rate, from an initial inter-pupil distance of 65 mm to a final inter-pupil distance of 380 mm, over 850 msecs.

Results

Only data from the anterior-posterior axis (corresponding to approach and withdrawal actions) were considered in the present analysis. To correct for any minor inconsistencies in starting position, for each trial, difference scores were calculated by subtracting the position at each point sampled from the initial position. The resulting scores represent the participant's head position relative to their starting point, with positive values indicating movement in the anterior direction (i.e., toward the image),

[2] For details see: http://www.hitlabnz.org/wiki/VisionSpace

while negative values represent movement in the posterior direction (i.e., away from the image).

Mean change in head position when the target face reached its maximum size (i.e., at 850msecs) was compared using a 3 (Facial expression: Neutral / Non-enjoyment smile / Enjoyment smile) x 2 (Target sex: Male / Female) repeated measures ANOVA. This revealed a main effect of facial expression, $F(2,78) = 11.69$, $p < 0.001$, $\eta_p^2 = 0.23$ (see Figure 1, top panel). Post-hoc analysis (Tukey *a*, $p < 0.05$) indicated that participants exhibited a significantly greater magnitude of movement toward faces displaying spontaneous enjoyment smiles ($M = 2.2$ mm, $SE = 0.3$), than those displaying either non-enjoyment smiles ($M = 1.0$ mm, $SE = 0.3$) or neutral expressions ($M = 0.1$ mm, $SE = 0.4$), which in turn were not significantly different from each other ($p = 0.13$). A main effect of target sex was also revealed, $F(1,39) = 4.55$, $p = 0.04$, $\eta_p^2 = 0.10$ (see Figure 1, bottom panel), indicating a greater magnitude of movement toward female faces ($M = 1.5$ mm, $SE = 0.4$) than male faces ($M = 0.7$ mm, $SE = 0.2$). No interaction effect was revealed ($F < 1.8$). Additional descriptive statistics and analyses are presented in the supplementary electronic Appendix A.

Discussion

Clear differences in approachability as a function of the facial expression of the target individual were revealed. More anterior movement (i.e., decreasing interpersonal distance) was revealed when the approaching target was displaying a positive emotional state (i.e., an enjoyment smile), compared to expressions unrelated to positive emotion (i.e., either a non-enjoyment smile or a neutral expression). These results support the claim that perceivers are sensitive to the subtle but meaningful

physiognomic information that differentiates enjoyment and non-enjoyment smiles (Frank et al., 1993; Miles & Johnston, 2007; Surakka & Hietanen, 1998). Further, this sensitivity was manifest in a manner consistent with the affordances specified by the respective expressions. Enjoyment smiles elicited approach behavior, consistent with the interaction opportunities provided by a happy person. Conversely, non-enjoyment smiles and neutral expressions were not met with the same approach behavior, again consistent with the hypothesised ambiguity of these expressions with respect to revealing dispositional properties relevant to approach and interaction.

It was also revealed that female targets were perceived as more approachable as shown by a greater magnitude of anteriorally-directed movement. An affordance-based explanation of this result requires the identification of population level sex differences with respect to interaction opportunities. Quite what such properties are is open to speculation. Nonetheless, a canvass of the literature reveals two prominent schools of thought, both of which are broadly consistent with the present results. Biologically based accounts (e.g., Becker, Kenrick, Neuberg, Blackwell & Smith, 2007) suggest that patterns of human sexual dimorphism (e.g., males are bigger, stronger and more aggressive) means that all else being equal, interactions with males may simply be more dangerous, leading to males being less approachable. Alternatively, more sociocultural accounts (e.g., Deaux & LaFrance, 1998) indicate that females are stereotypically perceived as more communal and affiliative, resulting in females being more approachable. Importantly, an affordance analysis does not necessarily differentiate between these approaches in that affordances can be shaped by a variety of factors including perceptual learning (Gibson, 1969) and natural

selection (Reed, 1996). Thus, the precise nature of sex-specific affordances remains speculative.

The quantification of postural adjustments as a measure of approachability avoids the ambiguities of reifying specific motor actions as approach and withdrawal indices (Maxwell & Davidson, 2007) and provides a direct assessment of on-line social evaluations. Interestingly, when substantial postural movements occurred, they were exclusively in an anterior direction. This may not be expected based on prior work by Schiff, Caviness and Gibson (1962) who demonstrated that rhesus monkeys withdrew or ducked when viewing a looming shape. However, notwithstanding differences in the species of participants, a critical distinction between the studies lies in the targets; expanding circles compared to human faces. Faces are powerful, attention grabbing stimuli which may act as attractors, inviting approach and literally pulling the perceiver toward interaction (cf., Shaw & Kinsella-Shaw, 2007). The significance of faces for social perception and action is underscored by the fact that differences in countenance alone were sufficient to systematically modulate posture in the service of the regulation of interpersonal distance, and ultimately opportunities for interaction. This further demonstrates that postural control systems can be flexibly adaptive in order to facilitate suprapostural activity (Stoffregen et al., 1999), in this case social activity.

One intriguing implication raised by these results concerns the role of individual differences in sensitivity to social information. Could, for example, those who fail to distinguish between smiles be opening themselves to exploitation? Or are they missing important opportunities for interaction? It is clear that individuals who

experience severe deficits in social perception such as those with autism do not detect the same social affordances as others (Loveland, 1991), but little is known about the consequences of more subtle impairments. Moreover, consistent with the effects characteristic of action priming (e.g., Tucker & Ellis, 1998), the present results reinforce the notion that detecting an affordance spontaneously facilitates behavior consistent with acting upon that affordance. Without instruction to attend to facial expression or any other approach-relevant information, exposure to information specifying the social affordance of approachability was accompanied by approach behavior. In this sense, differences in the perception of affordances were directly revealed in differences in action, closing the metaphorical social perception-action loop while also highlighting the utility of a focus on behavior when examining psychological phenomena (Baumeister, Vohs, & Funder, 2008).

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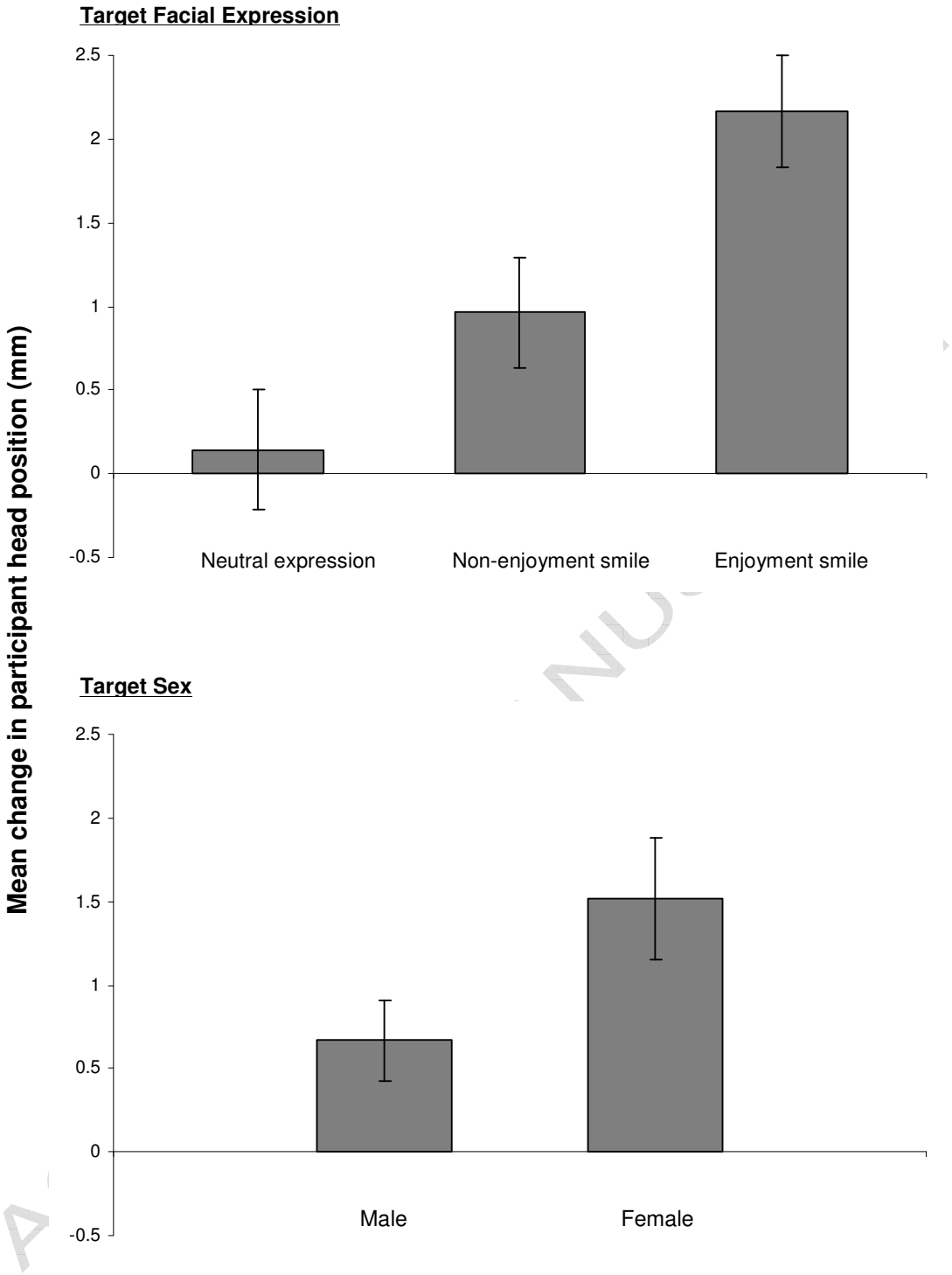

Figure 1.
Mean change in participant head position at 850 msecs (i.e. maximum face size) as a function of target facial expression (top panel) and sex (bottom panel). Error bars indicate ±1 standard error of the mean.