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**Facial first impressions from another angle: How social judgements are influenced by changeable and invariant facial properties**

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**Abstract**

First impressions made to photographs of faces can depend as much on momentary characteristics of the photographed image (within-person variability) as on consistent properties of the face of the person depicted (between-person variability). Here we examine two important sources of within-person variability: emotional expression and viewpoint. We find more within-person variability than between-person variability for social impressions of key traits of trustworthiness, dominance and attractiveness, which index the main dimensions in theoretical models of facial impressions. The most important source of this variability is the emotional expression of the face, but the viewpoint of the photograph also affects impressions, and modulates the effects of expression. For example, faces look most trustworthy with a happy expression when they are facing the perceiver, compared to when they are facing elsewhere, whereas the opposite is true for anger and disgust. Our findings highlight the integration of these different sources of variability in social impression formation.

**Keywords:** 'face perception', 'first impressions', 'person perception' 'viewpoint', 'emotional expression', 'social judgements'

**Introduction**

**Facial first impressions**

When encountering a stranger, people readily and rapidly make impressions of their character based on their facial appearance (Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015). Although these facial first impressions may seem superficial, they can have surprisingly important consequences. For example, impressions of competence, trustworthiness and attractiveness from face photographs can predict real political, financial, and legal outcomes (see Olivola, Funk, & Todorov, 2014; Todorov et al., 2015 for reviews).

Recent studies have found that dimensions of trustworthiness, dominance and youthful-attractiveness underlie a wide range of facial first impressions (Oosterhof & Todorov, 2008; Sutherland et al., 2013; Walker & Vetter, 2009). The trustworthiness dimension is hypothesised to represent a judgement of a target's helpful or harmful intentions towards the perceiver and the dominance dimension is suggested to represent a judgement of a target's capability in carrying out their intentions (Oosterhof & Todorov, 2008). Together, these two aspects of social judgement are suggested to have resulted from mechanisms that evolved to appraise threat (Oosterhof & Todorov, 2008). The third, youthful-attractiveness dimension is suggested to either reflect appraisals linked to sexual selection motivations related to mate choice, or more general social appraisals of age and health (Sutherland et al., 2013).

Most studies of facial first impressions use photographs as stimuli, and the importance of understanding the impressions created from photographs is underscored by the fact that so many social interactions now begin online (Sedghi, 2014; YouGov, 2014). However, although impressions of trustworthiness, dominance and attractiveness are often assumed to

reflect enduring characteristics of the face depicted in a photograph, the variance in social impressions of naturalistic photographs of the same individuals can be as large as the variance in impressions between photographs of different individuals (Jenkins, White, Van Montfort, & Burton, 2011). For example, using naturalistic images sampled from the internet, Jenkins and colleagues showed that impressions of an individual's facial attractiveness differed more depending on the photograph chosen (the within-person variability) than on the individual actually depicted (the between-person variability: Jenkins et al., 2011). Since then, Todorov and Porter (2014) have shown that the within-person variability in naturalistic photographs was also either equivalent to or exceeded the between-person variability for facial judgements of competence, creativity, cunning, extraversion, meanness, smartness and trustworthiness (see also Hehman, Flake, & Freeman, 2015).

These striking findings have been based on 'ambient images' of faces; that is, naturalistic photographs of individuals that were deliberately left free to vary on a wide range of cues. Studies using ambient images offer an important perspective by allowing insight into the breadth of cues available and the ways in which they are used in everyday life (Burton, Jenkins, & Schweinberger, 2011; Sutherland et al., 2013; Vernon, Sutherland, Young, & Hartley, 2014). However, because the ambient images approach often reveals the influence of multiple cues to impressions, this approach can also usefully be complemented by studies based on the more conventional method of systematically investigating the different contributory factors using posed images. Here, we take this more systematic approach to the question of how inter-image variability may contribute to facial first impressions.

The differences between photographs of faces can be characterised as representing (at least) three broadly defined sources of information that may contribute to facial impressions. First,

3

real-life photographs of individuals' faces often differ considerably on what Haxby and others have referred to as 'changeable' aspects of faces, such as the gaze direction or emotional expression of the face, or the viewpoint of the image (Andrews & Ewbank, 2004; Bruce & Young, 2012; Haxby, Hoffman, & Gobbini, 2000). Because these cues can change from moment to moment, they may differ even between photographs of the same individual taken in quick succession. Second, real-life photographs of different individuals will differ on relatively invariant aspects of the face, such as cues associated with the person's identity, gender, age, hairstyle, facial hair, and facial paraphernalia (e.g. glasses, facial jewellery). Third, photographs of faces also vary on non-facial characteristics of the environment, including scene characteristics and camera characteristics. Scene characteristics include the surrounding lighting, the position of the individual in the scene, and any visible extra-facial background. Camera characteristics include the lens used, the focal distance, the quality of the camera sensor, and colour settings (colour mode, white balance, and so forth). Since ambient images vary on all of these characteristics at once, it is an interesting and open question as to how these different aspects of the facial photograph contribute to the within-person variability in facial impressions. Here, we systematically investigate the contributions of changeable and relatively invariant facial characteristics using images that carefully control for environmental characteristics by photographing the faces under standard conditions.

**Invariant and changeable cues to facial impressions**

The distinction between changeable and invariant facial cues offers a useful place to start because it forms the basis of influential cognitive and neural theoretical models of face perception (Bruce & Young, 1986; Haxby et al., 2000) and is used in many empirical studies in face perception and computer face recognition (e.g. Hancock, Bruce, & Burton, 2000; Zhu

& Ramanan, 2012). Within the changeable part of Haxby's neural model of face perception (Haxby et al., 2000), a further distinction is often drawn between rigid and non-rigid deformations of the face (e.g. Andrews & Ewbank, 2004; Bruce & Young, 2012; Hancock et al., 2000). For example, emotional expression is a relatively non-rigid facial deformation because it changes the shapes and positions of facial features, whereas the viewpoint of the face represents a relatively rigid rotational change that affects the whole face. Examining the contribution of these two types of changeable cues, in contrast to invariant properties of the face (e.g. consistent structural characteristics that signal face identity or gender), therefore offers a principled way to examine the question of within-person variability.

The changeable cue of emotional expression is well-known to affect inferences of social attributes, including trustworthiness, dominance and attractiveness (Knutson, 1996; Willis, Palermo, & Burke, 2011; Zebrowitz, Kikuchi, & Fellous, 2007). In general, anger and disgust decrease perceived affiliation, trustworthiness and attractiveness, whereas happiness increases these attributions (Caulfield, Ewing, Burton, Avard, & Rhodes, 2014; Knutson, 1996; Reis et al., 1990; Willis et al., 2011; Zebrowitz et al., 2007, but see Mueser, Grau, Sussman, & Rosen, 1984; Penton-Voak & Chang, 2008). In addition, sadness and fear reduce perceived dominance, whereas anger and sometimes happiness increase dominance (Hareli, Shomrat, & Hess, 2009; Montepare & Dobish, 2003; Zebrowitz et al., 2007). However, studies tend to only investigate a couple of emotion expressions at a time (mainly happiness and/or anger: e.g. Caulfield et al., 2014; Reis et al., 1990), or only one trait impression at a time (e.g. Hareli et al., 2009; Willis et al., 2011). This approach makes it difficult to directly compare the effects of emotional expressions on different social attributions (for exceptions see Knutson, 1996; Zebrowitz et al., 2007). Understanding how a range of explicit emotional expressions relates to different social attributions is important because theoretical models of

social attributions explicitly relate emotional expression to some social attributions (such as trustworthiness) but not to others (such as dominance or attractiveness: Oosterhof & Todorov, 2008; Sutherland et al., 2013).

A couple of studies have now specifically related the emotional expression of the face to within-person variability. Hehman et al. (2015) found that judgements of intentionality (i.e. warmth, trustworthiness) differed across multiple naturalistic images of the same individuals and that this was largely based on smiling as a cue to positive intentionality, relative to anger (Hehman et al., 2015). Todorov and Porter (2014) also found that the presence of open-mouthed smiling positively changed perceptions of the trustworthiness and attractiveness of different naturalistic photographs of the same individuals. However, they also found this cue could not entirely explain the within-person variability present in judgements of trustworthiness or attractiveness. It is currently unknown to what extent smiling affects the within-person variability in perceived dominance, or how other emotional expressions may contribute to this within-person variability in general.

Studies have now also started to examine possible effects of viewpoint on facial impressions. These have focused mainly on changes in vertical viewpoint (pitch), showing that faces with upwards head tilt look more dominant, with a wider face and a heavier physique (Chiao et al., 2008; Mignault & Chaudhuri, 2003; Schneider, Hecht, & Carbon, 2012; Vernon et al., 2014), whereas those with a downwards tilt look more submissive, with a narrower face and a lighter physique (Chiao et al., 2008; Mignault & Chaudhuri, 2003; Schneider et al., 2012; Vernon et al., 2014; but see Hehman et al., 2015). Remarkably, only one study has examined the effect of horizontal (rotational) facial viewpoint on facial first impressions, despite the fact that we often see faces from different viewpoints in real life (Rule, Ambady, & Adams

Jr, 2009). This study found that perceivers show considerable consistency in their impressions of the same neutral target faces across frontal and three-quarter profile viewpoints, including impressions of trustworthiness, dominance and attractiveness (Rule et al., 2009).

This consistency in impressions of the same people across changes in horizontal viewpoint (Rule et al., 2009) suggests that the horizontal viewpoint may not contribute as strongly to the within-person variability of impressions of faces as does emotional expression. This point is not trivial, because the visual change in a photograph with a change in horizontal viewpoint is far greater than the more subtle visual differences that result from changes in emotional expression. Moreover, a change in horizontal viewpoint will also change the apparent social intentions of the face as being directed towards or away from the perceiver, so viewpoint is also a crucial social cue (assuming that the gaze direction is congruent with viewpoint, as in Rule et al.'s 2009 study). Everything else being equal, a person directly confronting the perceiver may be perceived as more dominant, for example, than a person facing away (as for averted pitch: Mignault & Chaudhuri, 2003). The contribution of horizontal viewpoint to within-person variability in social impressions has yet to be directly quantified or compared to the contribution of emotional expression.

Interestingly, there are theoretical reasons to expect that the emotional expression and the horizontal viewpoint of the face might also *interact* to produce impressions. An emotional target who is facing the perceiver will appear to be directing their emotion (and accompanying intentions) at the perceiver rather than elsewhere, and in this case, the emotional expression might have a stronger effect on impressions. This interaction may be particularly important for trustworthiness impressions, which are hypothesised to represent a

judgement of intentionality (e.g. Oosterhof & Todorov, 2008). For example, anger should look less trustworthy on a face that is directly confronting the perceiver, whereas happiness should look more trustworthy. Indeed, in support of this suggestion, exactly this pattern of emotional amplification for trustworthiness has been found when another cue to intentionality, gaze direction, is manipulated (Willis et al., 2011). Specifically, Willis and colleagues (2011) found that angry faces looked less trustworthy and happy faces looked more trustworthy when the targets' gaze was directed at the perceiver rather than averted. It remains to be established whether this finding for trustworthiness also extends to a change in viewpoint, because Willis and colleagues (2011) employed frontal facing images only. Finally, it is unclear how viewpoint and expression may combine to form impressions of social judgements along the other dimensions in models of facial impressions (Oosterhof & Todorov, 2008; Sutherland et al., 2013), including dominance and attractiveness. These attributes are not theorised to rely on the intentionality of the target, unlike trustworthiness (Oosterhof & Todorov, 2008; Sutherland et al., 2013) and so may be less influenced by the direction of the gaze or viewpoint of the target in combination with the emotional expression.

**Current study**

The current study aimed to establish the effects of the changeable cues of emotional expression and horizontal viewpoint, and their interaction, on impressions of trustworthiness, dominance and attractiveness from faces. We included trustworthiness, dominance and attractiveness to index the three main dimensions of facial first impressions (Oosterhof & Todorov, 2008; Sutherland et al., 2013). In doing so, we examined a wider range of emotional expressions and social impressions than have been examined so far together. We also examined the main effect of horizontal viewpoint (i.e. head orientation) on a wider range

of face images than has yet been examined. Finally, we investigated the interaction between viewpoint and emotional expression on these facial impressions for the first time.

In order to investigate the effects of these cues on facial impressions, we collected ratings of the trustworthiness, dominance and attractiveness of face photographs taken from the Karolinska Directed Emotional Face database (Lundqvist, Flykt, & Öhman, 1998). We chose the KDEF because it is one of the most widely used databases of facial emotions, because it contains multiple views of the face, and because the leading model of facial first impressions was built on the neutral images from this database (Oosterhof & Todorov, 2008).

A secondary aim was to publically release the ratings of the impressions for the faces in this database for use in future research, as a valuable supplement to the face images, which are themselves already publically available. Ratings of trustworthiness, dominance and attractiveness already exist for neutral, frontal-facing images in this database (Oosterhof & Todorov, 2008, available at: http://tlab.princeton.edu/databases/). Here, we expand on this existing database by also including impression ratings for the emotionally expressive faces (anger, disgust, happiness, sadness, and fearful expressions) in addition to the neutral faces, and for the faces viewed from other angles (three-quarters and full profile viewpoint) in addition to the frontal-facing images.

We predicted that differences in emotional expression would influence social impressions to multiple images of the same people, and that this cue would explain as much or more variation in social impressions than explained by the identity of the face. In contrast to emotion, we expected that the horizontal viewpoint of the face would not explain much variance in the impressions across images of the same people (following Rule et al., 2009).

Finally, we predicted that the effects of emotional expression would be stronger from a frontal viewpoint compared to profile viewpoints, especially for trustworthiness, because these intentions should appear stronger or more relevant when aimed at the perceiver, all else being equal. This hypothesis is based on the previous theoretical description of first impressions, as representing appraisals of faces in terms of the potential consequences for the perceiver. We expected that the effect of viewpoint would depend on both the emotional expression of the face and the social judgement made, based on previous studies that have examined the effect of emotional expression on social judgements, as outlined previously (Hareli et al., 2009; Knutson, 1996; Main, DeBruine, Little, & Jones, 2010; Montepare & Dobish, 2003; Zebrowitz et al., 2007). For example, happiness should be perceived as especially trustworthy and attractive when the face was viewed in a frontal viewpoint relative to profile viewpoints. Similarly, anger and disgust should look least trustworthy, least attractive and most dominant from a frontal viewpoint, whereas fear and sadness should look least dominant and least attractive from a frontal viewpoint.

**Method**

**Participants**

Forty-eight Caucasian adult participants were recruited (trustworthiness group: mean age = 25.1, age SD = 6.0, age range = 18-38 years; dominance group: mean age = 24.2, age SD = 6.5, age range = 18-38; attractiveness group: mean age = 21.9, age SD = 4.3, age range = 18-32). Two additional participants were tested (in the dominance and attractiveness groups) but were excluded before any analyses because they appeared not to be paying attention to the task. The participants were divided into three groups of sixteen participants each, with each group rating a different attribute (trustworthiness, dominance or attractiveness; groups were gender balanced, with eight male and eight female participants in each group). Participants

were tested on an iMac computer in a quiet room, with ratings collected via PsychoPy (version 2: Peirce, 2008). Participants gave their informed consent for procedures that were approved by the University ethics committee, and were either given course credit or a small honorarium ($10) for their participation.

**Stimuli**

Our stimuli were 1,152 images of 64 Caucasian target faces (32 male) taken from the Karolinska Directed Emotional Face set (KDEF: Lundqvist et al., 1998). We examined the three main viewpoints available in the KDEF database: forward-facing, three-quarter profile and full profile. We counterbalanced the direction of the viewpoint (facing leftwards versus rightwards) across face identities and participants (i.e. half of the participants saw one half of the target identities facing to the left, and the other half to the right and vice versa). We examined six of the seven emotional expressions available from the KDEF, including happiness, anger, fear, disgust, sadness and neutral expressions. We dropped surprise, to reduce the length of the experiment, and because the status of surprise as an emotional expression is currently debated (Tracy & Randles, 2011).

The KDEF contains two very similar images of each target identity, at each expression and viewpoint (an 'A' set and a 'B' set). Unfortunately, some individual images within both the 'A' and 'B' sets show a marked (and apparently random) luminance difference from the rest of the images. To maintain consistency in image luminance, since we wished to control for environmental characteristics, images were always chosen from the 'A' set, except where there was a marked inconsistency in luminance in an individual 'A' image, when a 'B' set image was substituted instead. We included all available target identities except for five target identities that were unfortunately affected by luminance inconsistencies in both 'A'

and 'B' sets, along with one other female face, dropped to keep the stimuli gender balanced. This procedure is in line with other studies which use the KDEF to understand facial impressions (e.g. Oosterhof & Todorov, 2008).

Participants rated all 1,152 face images (64 target identities x 6 emotions x 3 viewpoints) so that their judgements were made relative to the full variability in the database (i.e. identities, emotions and viewpoints). Note that this design is likely to be conservative in terms of finding an interaction, because participants could have simply relied on the identity or emotion of the face as a strong cue to their facial first impressions.

**Procedure**

Participants rated the face images in random order on either their trustworthiness, dominance or attractiveness on a scale of 1-7 (*not at all - very*). Twelve face images were additionally shown first as a practice; these were selected from the experimental images so that they were distributed across expression, sex, identity and viewpoint conditions, in order to give the participants an idea of the variability present in the image database. The practice ratings were not analysed.

Each face was displayed on the screen for 1,000 ms, but participants were told that they could take as long as they wanted to respond (although they were encouraged to go with their gut instinct, as in previous research: Oosterhof & Todorov, 2008). After rating, the next face appeared after an ISI of 750 ms. On average, the participants took around an hour to make their ratings, and spent around 1,700 ms on average (SD: 500 ms) on each face image. The time taken is broadly comparable to previous facial first impressions research (Rule et al., 2009; Sutherland, Rowley, et al., 2015). The trials were split into four blocks (each

containing 288 images) with a rest screen in between to avoid participant fatigue, although participants were also told that they could take a break whenever they wanted, as long as they remembered what rating they would give the face that was displayed when they took their break.

## Results

### Reliability

The ratings showed good reliability across participants, with Cronbach's alphas of 0.89 for trustworthiness, 0.88 for dominance and 0.88 for attractiveness. In addition, the trustworthiness, dominance and attractiveness ratings for the subset of neutral, forward-facing images correlated reasonably highly with previous ratings of trustworthiness, dominance and attractiveness collected for these images by Oosterhof and Todorov (2008): trustworthiness $r = .79$, $p < .001$, dominance $r = .78$, $p < .001$, attractiveness $r = .63$, $p < .001$, ($n = 62$, based on the intersection of our image set with this previous one).

### Viewpoint direction

As the direction of the non-frontal viewpoint (left or right facing image, i.e. facing to the left or right hand side of the viewer) was not of theoretical interest in the current paper, we counterbalanced this factor across participants to keep the number of trials within a manageable limit (see methods). To ascertain the effect of the direction of the viewpoint, we correlated the average ratings given to the left and right facing three-quarter and profile images. Agreement between the average ratings given to the left and right-hand facing three-quarter and profile images was high: trustworthiness $r = .74$, $p < .001$, dominance $r = .74$, $p < .001$, and attractiveness $r = .78$, $p < .001$ (all $n = 768$ i.e. 64 identities x 6 emotions x 2 viewpoints). There was an overall mean difference so that the right facing images received

slightly, but significantly, higher ratings across all emotion and viewpoint conditions: $F(1,63)$ = 4.91, $p$ = .030, $\eta_p^2$ = .07 (mean rating right facing images: 3.22; left facing images: 3.18; SEM difference: 0.02). Importantly, the direction of the viewpoint did not interact with emotional viewpoint or expression (all $F$s < 1.87, all $p$s > .16, all $\eta_p^2$ ≤ .03) so we collapsed across this factor.

**The contribution of changeable cues to within-person variability**

We examined the relative overall importance of between-person variability in social impressions (i.e. variability across face images of different people) and within-person variability in social impressions (i.e. variability across all face images, including multiple images of the same people: see Todorov & Porter, 2014; see **figure 1**). We used a $t$-test to directly compare the between-person and within-person variance across the three social attribute and male and female face conditions (as Todorov and Porter 2014). We found significantly more within-person variability than between-person variability (after log-transforming the data to account for the bounded nature of variance coefficients: $t(5)$ = 7.10, $p$ < .001, $d$ = 2.90, untransformed mean difference = 0.58, SEM difference = 0.10; note that a simple sign test on the original data was also significant, $p$ = .031; see **figure 1**). This pattern replicated the results found with ambient face images (Hehman et al., 2015; Jenkins et al., 2011; Todorov & Porter, 2014) using a more constrained set of face images that only varied on their emotional expression and viewpoint.

**Figure 1 about here**

We then examined the contribution of emotional expression and viewpoint to within-person variability in impressions by using the same analyses as Todorov and Porter (2014), who

correlated social impression ratings across different sets of images of the same individuals to quantify the lack of within-person variability. However, the crucial difference between the current study and this previous one is that by using the KDEF images, the current study can assess these within-identity differences as resulting from the effects of either emotional expression or viewpoint. To accomplish this aim, we correlated judgements of the same faces across emotional expression conditions while collapsing across viewpoint (emotional expression within-person variability; see **table 1 and supplementary figure S1**), and correlated judgements of the same faces across viewpoint conditions while collapsing across emotional expression (viewpoint within-person variability; see **table 2 and supplementary figure S2**). The lower the correlations in the tables are, the greater the variability across images of the same people (i.e. the greater the within-person variance relative to the between-person variance).

These correlations showed that the effects of within-identity variability are largely due to emotional expression, with numerically lower correlations between emotional expression conditions than across viewpoint conditions, at least for trustworthiness and dominance (see **tables 1 and 2, and supplementary figures S1 and S2**). To statistically test this observation, we directly compared the amount of within-person variation in the emotional expression condition with the within-person variation in the viewpoint condition, across the three social attribute and male and female face conditions (using a $t$-test, as Todorov & Porter, 2014). Significantly more variability in the social attribute ratings was indeed found for changes in the emotional expression of the face than for changes in the viewpoint of the face: $t(5) = 6.15$, $p < .005$, $d = 2.51$, untransformed mean difference = 0.50, SEM difference = 0.10 (again, after log-transformation; a sign test on the original data was also significant: $p = .031$).

Finally, the within-person variability was also higher for trustworthiness and dominance than for attractiveness (see **tables 1 and 2, supplementary figures S1 and S2**), as also found by Todorov and Porter (2014) using ambient images. We statistically verified this observation by examining the average correlations between the viewpoint and emotional expression image sets ($n = 18$, taken from **tables 1 and 2**, after Fisher transformation) in a one-way repeated-measures ANOVA to compare the three social attributes (trustworthiness, dominance and attractiveness): $F(1.50, 25.43) = 236.48$, $p < .001$, $\eta_p^2 = .93$. We found significantly less variability across different image sets for ratings of attractiveness (average $r = .91$) compared to trustworthiness (average $r = .70$) or dominance (average $r = .48$); both $t(17) \geq 16.64$, $p < .001$, $d \geq 3.92$. There was also less variability in the trustworthiness ratings compared to the dominance ratings: $t(17) = 8.89$, $p < .001$, $d = 2.12$.

**Tables 1 and 2 about here**

**Emotional expression and viewpoint interact to form impressions**

In order to investigate the specific effects of these changeable facial cues on impressions, we then entered the impression ratings into a mixed ANOVA with three factors: social judgement (between-subjects: trustworthiness, dominance and attractiveness), emotional expression (within-subjects: angry, disgusted, happy, sad, fearful and neutral) and viewpoint (within-subjects: frontal, three-quarters profile and full profile). We also examined participant gender and face gender at this point, but these factors did not qualify the theoretically interesting three-way interaction (see below) so were dropped (i.e. there were no significant four- or five way interactions when participant and face gender were included; all $Fs < 2.03$, all $ps > .097$). All analyses were corrected for sphericity using the Huynh-Feldt correction (decided *a priori*) where appropriate.

As predicted, there was a significant two-way interaction between the emotional expression and the social judgement: $F(10, 225) = 34.66$, $p < .001$, $\eta_p^2 = .61$, but not between the viewpoint and the social judgement: $F(4, 90) = 1.36$, $p = .26$, $\eta_p^2 = .06$. **Figure 2** presents the overall effect of emotional expression for each social judgement, and demonstrates that the emotional expression is clearly a strong cue to all three impressions. However, the effect of the emotional expression condition was different for each social judgement (for all emotions there was a significant main effect of social judgement: all $F$s > 3.77, all $p$s < .031, all $\eta_p^2$ > .14). For example, happiness increased trustworthiness and attractiveness relative to dominance, whereas sadness lowered dominance and attractiveness relative to trustworthiness (see **figure 2**).

**Figure 2 about here**

These effects of emotional expression and trait impression were further qualified by a significant three-way interaction with viewpoint, as predicted: $F(17.48, 393.18) = 5.85$, $p < .001$, $\eta_p^2 = .21$. As a result, we examined the interaction between emotional expression and viewpoint for each social judgement separately.

*Trustworthiness*: We examined the effect of emotional expression (six levels: anger, disgust, fear, sadness, happiness and neutral) along with viewpoint (frontal, three-quarters profile or full profile) and their interaction on impressions of trustworthiness using a repeated-measures ANOVA. There was a significant main effect of emotional expression: $F(2.30, 34.54) = 37.22$, $p < .001$, $\eta_p^2 = .71$, but not viewpoint: $F(1.35, 20.20) = 2.68$, $p = .11$, $\eta_p^2 = .15$.

The main effect of emotional expression was qualified by a significant interaction with viewpoint: $F(5.74, 86.05) = 8.58$, $p < .001$, $\eta_p^2 = .36$. We therefore analysed the effect of viewpoint on trustworthiness impressions separately for each emotional expression (see **figure 3A**).

As predicted, there was a significant main effect of viewpoint on trustworthiness for happy faces: $F(1.58, 23.74) = 6.63$, $p < .01$, $\eta_p^2 = .31$, angry faces: $F(1.39, 20.87) = 8.78$, $p < .005$, $\eta_p^2 = .37$, and disgust faces: $F(1.43, 21.51) = 10.06$, $p < .005$, $\eta_p^2 = .40$ (see **figure 3A**). Planned comparisons indicated that the frontal happy faces were rated as more trustworthy than both the three-quarter and the full profile happy faces, whereas the frontal anger and disgust faces were rated as less trustworthy than the three-quarter and full profile anger and disgust faces: all $t(15) \geq 2.40$, all $p$s $\leq .03$, all $d$s $\geq 0.60$.

There were also unpredicted significant main effects of viewpoint on trustworthiness for the fearful: $F(2, 30) = 4.19$, $p = .025$, $\eta_p^2 = .22$ and neutral faces: $F(1.46, 21.96) = 7.92$, $p < .005$, $\eta_p^2 = .35$ (see **figure 3A**). Post-hoc comparisons indicated that the frontal fearful and neutral faces were rated as significantly less trustworthy than the three-quarter fearful or neutral faces: both $t(15) \geq 3.43$, $p < .005$, $d \geq 0.86$, although there was no difference in either case between the frontal and full-profile faces: both $t(15) \geq 1.34$, $p \leq .20$, $d \geq 0.33$. Since we did not predict these findings for fearful and neutral faces, and because there is no obvious explanation for these findings, we refrain from interpreting them. The effect of viewpoint was not significant for sadness: $F(2, 30) < 0.24$, $p > .79$, $\eta_p^2 = .02$.

**Figure 3 about here**

*Dominance*: There was a significant main effect of emotional expression: $F(2.54, 38.08) = 38.40$, $p < .001$, $\eta_p^2 = .72$; but not viewpoint: $F(2, 30) = 0.24$, $p = .79$, $\eta_p^2 = .02$. As for trustworthiness, the main effect of emotional expression was qualified by a significant interaction with the viewpoint: $F(8.09, 121.31) = 6.36$, $p < .001$, $\eta_p^2 = .30$ (**see figure 3B**).

As predicted, the effect of viewpoint on dominance was significant for the angry faces: $F(2,30) = 3.95$, $p = .03$, $\eta_p^2 = .21$, and the sad faces: $F(2,30) = 5.16$, $p = .01$, $\eta_p^2 = .26$ (see **figure 3B**). Planned comparisons showed that the frontal angry faces were rated as significantly more dominant than the full profile faces: $t(15) = 2.24$, $p = .04$, $d = 0.56$, but not differently to the three-quarter profile faces: $t(15) = 0.26$, $p = .80$, $d = 0.07$. The sad frontal faces were rated as significantly less dominant than the full profile faces: $t(15) = 2.66$, $p = .02$, $d = 0.66$, but not differently to the three-quarter profile faces: $t(15) = 0.63$, $p = .54$, $d = 0.16$.

Unexpectedly, viewpoint also affected the neutral faces: $F(2,30) = 3.84$, $p = .03$, $\eta_p^2 = .20$ (see **figure 3B**). Post-hoc comparisons indicated that the neutral frontal profile faces were also rated as significantly more dominant than the neutral full-profile faces: $t(15) = 2.50$, $p = .025$, $d = 0.62$; but not compared to the three-quarter profile faces: $t(15) = 1.05$, $p = .312$, $d = 0.26$. The effect of viewpoint on dominance was not significant for any other emotional expressions: all $F$s $\leq 2.35$, all $p$s $\geq .112$, all $\eta_p^2 \leq .14$.

*Attractiveness*: There were significant main effects of emotional expression: $F(1.24, 18.64) = 18.61$, $p < .001$, $\eta_p^2 = .55$; and viewpoint: $F(1.59, 23.82) = 6.03$, $p = .01$, $\eta_p^2 = .29$. These main effects were again qualified by a significant two-way interaction between emotion and viewpoint: $F(10, 150) = 6.18$, $p < .001$, $\eta_p^2 = .29$ (see **figure 3C**).

As predicted, the main effect of viewpoint on attractiveness was significant for the happy faces: $F(2, 30) = 6.19$, $p < .01$, $\eta_p^2 = .29$ and for the disgust faces: $F(1.54, 23.08) = 5.46$, $p = .02$, $\eta_p^2 = .27$ (see **figure 3C**). Planned comparisons showed that the frontal happy faces were rated as significantly more attractive than the three-quarter and full profile faces, whereas the disgust frontal faces were rated as less attractive than the three-quarter and full profile faces: all $t(15) \geq 2.27$, all $p$s $< .04$, all $d\underline{s} \geq 0.57$.

Unexpectedly, the main effect of viewpoint on attractiveness was also significant for fearful faces: $F(2, 30) = 4.32$, $p = .02$, $\eta_p^2 = .22$ and for neutral faces: $F(2, 30) = 18.10$, $p < .001$, $\eta_p^2 = .55$ (see **figure 3C**). As for trustworthiness, post-hoc comparisons indicated that the fearful frontal and neutral faces were rated as significantly less attractive than the three-quarter profile faces: both $t(15) \geq 2.89$, $p < .01$, $d \geq 0.72$; although there was no difference in either case between the frontal and full-profile faces: both $t(15) \leq 2.02$, $p \geq .061$. As before, we refrain from interpreting these unpredicted findings. The effect of viewpoint on attractiveness was not significant for any other emotional expressions: all $F(2,30) \leq 3.09$, $p$s $\geq .06$, all $\eta_p^2 \leq .17$.

**Online database**

The trustworthiness, dominance and attractiveness ratings of the 1,152 KDEF images can be accessed online ([NB: file will be uploaded in online **Supplementary materials]**). These data may be of use in future to researchers who are interested in understanding social impression formation from faces, as well as researchers who wish to select face stimuli so as to control for the first impressions these generate.

**Discussion**

Our findings show clearly that emotional expression can explain most of the variation in social judgements of trustworthiness, dominance and attractiveness, made to standardised photographs of faces that varied systematically in identity, expression, and viewpoint. Importantly, this variation in emotional expression contributed more to social judgements than did the identity of the face. These findings agree with a recent study which found that expressions varying from happy to angry contribute a great deal to variation in social judgements of naturally varying real face images and computer generated faces (Hehman et al., 2015). Here, we extend this finding to other emotional expressions and to carefully controlled photographs of real faces. This finding fits well with an existing body of work demonstrating that facial emotional expression is an important cue to first impressions (e.g. Hareli et al., 2009; Knutson, 1996; Willis et al., 2011; Zebrowitz et al., 2007). In contrast, the horizontal viewpoint of the face itself had less impact on the social attributions. This high agreement on facial impressions across different horizontal viewpoints replicates Rule et al.'s findings (2009), and extends their results from neutral to expressive faces.

Although the overall effect of viewpoint was relatively minor, we found that the viewpoint of the face interacted with the facial emotional expression to modify social impressions. Importantly, these interactions did not just reflect an overall halo for positive or negative emotional expressions, but were specific to particular combinations of social judgement, expression and viewpoint. For example, for impressions of trustworthiness, happy expressions were perceived as particularly trustworthy when the target was facing directly at the perceiver rather than away from the perceiver, whereas angry and disgusted expressions were perceived as least trustworthy in this case. These interactions follow the pattern of

results found by Willis and colleagues (2011) for gaze direction and trustworthiness perceptions. We suggest that these interactions occurred due to the change in apparent direction of intentions accompanying the change in viewpoint, in line with the intentionality account of facial trustworthiness (Oosterhof & Todorov, 2008). A person with an angry expression who is directly facing you, for example, will appear to have negative intentions towards you rather than to some other person or object and will thus look even less trustworthy. These perceptions may be adaptive, as an angry individual who is facing the perceiver is likely to pose more of an immediate threat than one who is facing away.

In terms of attractiveness, participants perceived happy face images as more attractive when the target was facing directly at the perceiver rather than away from the perceiver, whereas participants perceived disgusted (and neutral) face images as less attractive when facing towards rather than away from the perceiver. Our findings agree with a previous study that found that the viewpoint of the image qualified the effect of emotional expression on preferences for attractive and unattractive faces using a two-alternative forced-choice preference task (Main et al., 2010). Here, we extend Main et al.'s (2010) results to a rating task. Again, we suggest that the intentions behind the emotional expression can explain these results; for example, a happy expression looks more attractive when it appears to indicate that the target is socially interested in the perceiver rather than some other person or event. Main and colleagues (2010) have suggested that these perceptions may be adaptive, because such a mechanism would help perceivers focus attention on individuals who seem likely to reciprocate. Alternatively, or in addition, perceivers may find it hard to judge attractiveness from non-frontal faces given that facial cues to attractiveness such as symmetry and averageness may simply be harder to judge from non-frontal faces (e.g. Rhodes, Peters, Lee, Morrone, & Burr, 2005).

Interestingly, emotional expression and viewpoint also interacted to influence dominance judgements, although dominance is not theorised to rely on intentionality (Oosterhof & Todorov, 2008; Sutherland et al., 2013). Specifically, angry and neutral faces were perceived as most dominant and sad faces as least dominant when the target was facing towards the perceiver compared to a full profile viewpoint, although not compared to a three-quarters viewpoint. These effects are not predicted by current facial impression models (Oosterhof & Todorov, 2008; Sutherland et al., 2013), which place more emphasis on gender-related dominance (e.g. Oosterhof & Todorov, 2008; Sutherland, Young, Mootz, & Oldmeadow, 2015). However, these effects can be understood by considering the theoretical importance of dominance as a social judgement. Fundamentally, dominance is a judgement of a target's position in a social hierarchy; and indeed, perceivers' own dominance affects their perceptions of others' dominance from facial cues (e.g. Watkins, Fraccaro, et al., 2010; Watkins, Jones, & DeBruine, 2010). This theoretical point may help explain our current findings, because an emotional expression directed at the perceiver directly bears on their relative standing in a social hierarchy whereas an expression directed elsewhere does not. For example, an angry expression viewed from the front is tantamount to a social challenge directed at the perceiver. Our findings also agree with the results of previous work which found that another cue to dominance (facial masculinity) interacts with another cue to intentionality (perceived gaze direction) to produce dominance perceptions (Main, Jones, DeBruine, & Little, 2009). In this previous work, masculinity was also a stronger cue to dominance when viewed from the front (Main et al., 2010).

It is also worth highlighting that with a set of face images displaying clear and strong emotional expressions, the overall contribution of emotional expression to dominance

appears to be equally as important as for trustworthiness. This point is interesting in light of recent models of facial first impressions, which have tended to minimise the effect of emotional expression on dominance (e.g. Oosterhof & Todorov, 2008; Sutherland et al., 2013). Our finding that emotional expression played a large role in impressions of dominance agrees with other studies which have also found that perceivers use emotional expression as a cue to dominance when this cue is available (e.g. Hareli et al., 2009; Knutson, 1996; Montepare & Dobish, 2003). In line with a recent review of the field (Todorov et al., 2015), we suggest that models of social impressions need to develop a more detailed understanding of the pattern of relationships between facial cues and social judgements.

It is also interesting to consider our results more broadly in relation to images of faces from different viewpoints as seen outside the lab, in art or in real life. Since the Renaissance, artists have frequently used a three-quarter view in traditional portraiture (Baddeley & Woodhead, 1983). This artistic tradition may have arisen if three-quarter views are intuitively assumed to capture a likeness better (Bruce, Valentine, & Baddeley, 1987; Liu & Chaudhuri, 2002) or if three-quarter views do genuinely help people recognise unfamiliar others (e.g. Krouse, 1981; O'Toole, Edelman, & Bülthoff, 1998; Troje & Bülthoff, 1996; but see also Liu & Chaudhuri, 2002). Alternatively, three-quarter viewpoints may simply be easier to draw from real life than frontal viewpoints (Sir Lawrence Gowing, as cited in Reynolds & Tansey, 2003). Any advantage for a three-quarter profile view for facial identity recognition certainly contrasts with our current results, which instead show the largest differences in social processing from frontal views. Given the new trend for "selfie taking", it would be interesting to examine how "selfies", which usually involve the target directly facing the camera (see http://selfiecity.net), differ in their impact from classical portraiture, and how viewpoints in these real-life facial images affect social impressions. In terms of real-life applications, our

current results suggest that people choosing a frontal viewpoint for their photographs will maximise the first impressions created by these, whether positive or negative.

**Future directions**

In the current study, we examined viewpoint along the horizontal plane (rotation), but in future, viewpoint could also be examined in the vertical plane (pitch). Previous studies have found that the pitch of the face affects dominance perceptions, so that faces with upwards head tilt (as if viewed from below) look more dominant, proud, and self-assured, whereas downwards tilted faces (as if viewed from above) look more submissive, sad and ashamed (Chiao et al., 2008; Mignault & Chaudhuri, 2003; Vernon et al., 2014; but see Hehman et al., 2015). Pitch also affects judgements of judgements of other cues to facial impressions, including facial adiposity and facial width-height ratio, so that faces viewed from below have a larger facial width-height ratio and greater perceived facial adiposity (Schneider et al., 2012). It would be interesting to explicitly compare the contribution of pitch and emotional expression, and to investigate if pitch, like horizontal viewpoint, interacts with emotional expressions to produce social attributions. Future research could also examine whether emotional intensity mediates the interaction between viewpoint and expression, because previous research has found that emotional expressions look less intense when faces shift away from a frontal viewpoint (Guo & Shaw, 2015) or when the gaze direction of the face is averted rather than directed at the perceiver for frontal facing images (Willis et al., 2011).

Our study examined social impressions formed from static images without an explicit context, but future research could also consider how these impressions may change depending on the environmental or social context. For example, anger may look trustworthy when an individual is perceived to have a good reason to be angry (see Hess, Adams Jr, & Kleck, 2008 for a review of contextual effects). Another important open question is how well

25

impressions made from static photographs correspond with impressions made from dynamic and 3D faces. Recent evidence suggests that there is relatively high correspondence in impressions of attractiveness made to facial photographs and videos of the same targets (see Rhodes et al., 2011 for a review). The correspondence between static and dynamic faces remains to be established for other important facial impressions, such as trustworthiness or dominance.

Finally, here we took advantage of a carefully controlled image database to specifically target two important changeable facial cues and investigate their impact on the variability of facial impressions. In using this method in the present paper, we do not mean to imply that this approach should replace research using naturally varying ("ambient") images. The ambient images approach offers a number of important advantages (cf. Hehman et al., 2015; Jenkins et al., 2011; Sutherland et al., 2013; Todorov & Porter, 2014, but these inevitably come at the expense of some loss of control over the different factors involved in face perception. Hence, we suggest that future research employ both of these different approaches to generate complementary insights into how perceivers make social judgements from unfamiliar faces.

**Conclusions**

In summary, we investigated the contribution of invariant and changeable facial cues to impressions of trustworthiness, dominance and attractiveness. We established that the changeable cues (emotional expression and horizontal viewpoint) contributed more than the invariant cues (identity) to social impressions of trustworthiness, attractiveness and dominance. This effect was largely due to the changeable cue of emotional expression, which contributed more to variability across photographs of the same people than did the viewpoint of the photograph. We also found, however, that the viewpoint of the photograph interacts

with emotional expression to produce these facial impressions. Our findings thus highlight the complex and interactive nature of facial cues in social impression formation. When meeting a stranger for the first time, changeable facial cues such as emotional expressions are a salient influence on the first impressions generated by such an encounter, but are not the only influence. Other factors such as the orientation at which the face is viewed also matter, and can change the way in which the emotional expression of the face gives rise to a first impression.

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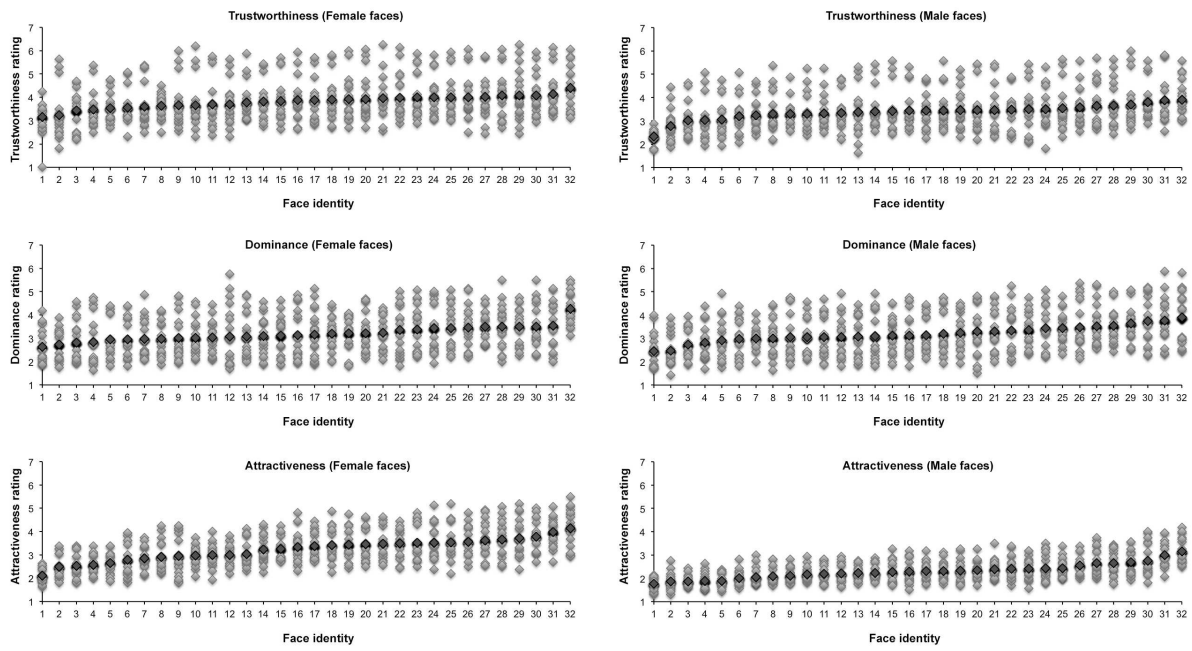
**Figure 1.** Mean trustworthiness (top), dominance (middle) and attractiveness (bottom) ratings, plotted separately for female faces (left) and male faces (right). Each column represents a single identity, and each point represents a single photo (the overall mean rating for each identity is shown as a darker point). The horizontal axis represents the between-person variability (the face identities, ranked by their overall mean trustworthiness, dominance or attractiveness). The vertical axis represents the within-person variability (the face photographs).
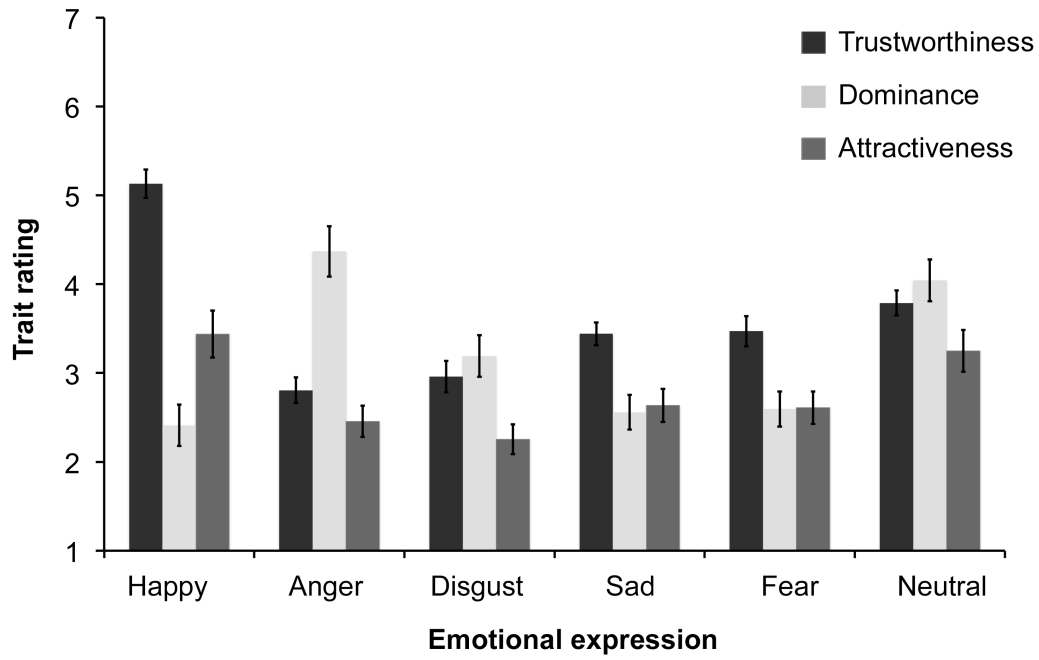
**Figure 2.** The contribution of emotional expression (collapsed across viewpoint) to facial impressions of trustworthiness, dominance and attractiveness. Error bars show ±1 the standard error of the mean (SEM).
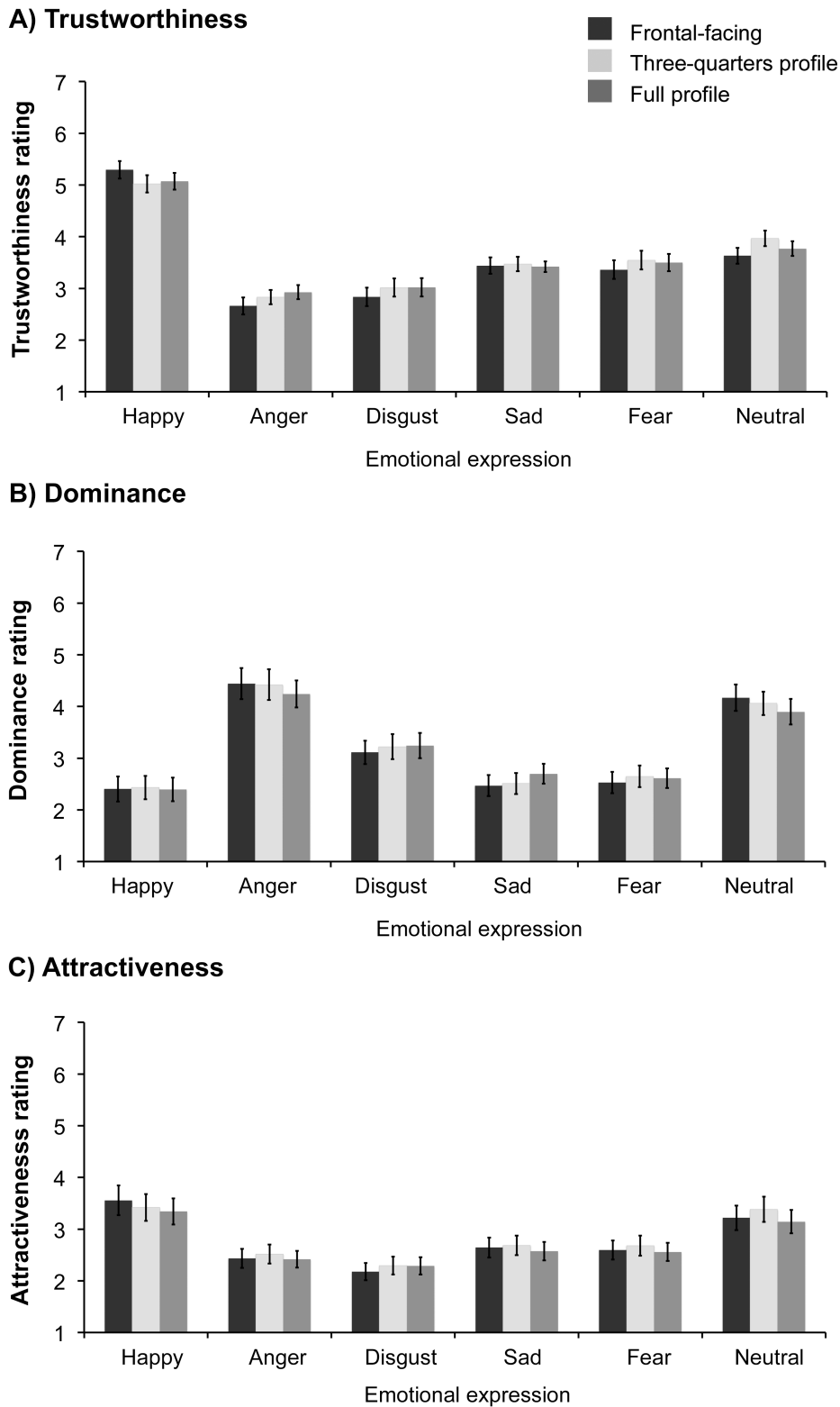
**Figure 3.** The contribution of emotional expression and viewpoint to facial impressions of trustworthiness, attractiveness, and dominance. Error bars show ±1 the standard error of the mean (SEM).

**Table 1.** Correlations between trait ratings for different emotions at the face level, collapsed across viewpoint. The last column shows the variance in trait ratings for each emotion condition separately (i.e. across different face identities).

| | | Happy | Anger | Disgust | Sad | Fear | Variance |
|---|---|---|---|---|---|---|---|
| Trustworthiness | Happy | - | | | | | .36 |
| | Anger | .58** | - | | | | .13 |
| | Disgust | .70** | .63** | - | | | .10 |
| | Sad | .68** | .61** | .64** | - | | .14 |
| | Fear | .67** | .62** | .68** | .76** | - | .15 |
| | Neutral | .71** | .65** | .67** | .69** | .67** | .29 |
| Dominance | Happy | - | | | | | .12 |
| | Anger | .41* | - | | | | .27 |
| | Disgust | .38* | .49** | - | | | .20 |
| | Sad | .45** | .33* | .48** | - | | .26 |
| | Fear | .26* | .42* | .47** | .36* | - | .21 |
| | Neutral | .57** | .51** | .41* | .39* | .23 | .19 |
| Attractiveness | Happy | - | | | | | .59 |
| | Anger | .91** | - | | | | .30 |
| | Disgust | .90** | .87** | - | | | .21 |
| | Sad | .91** | .88** | .91** | - | | .38 |
| | Fear | .91** | .90** | .90** | .92** | - | .39 |
| | Neutral | .94** | .87** | .89** | .88** | .91** | .64 |

** $p < .001$, * $p < .05$, all $n = 64$.

**Table 2.** Correlations between trait ratings at different viewpoints at the face level, collapsed across emotional expression. The last column shows the variance in trait ratings for each viewpoint condition separately (i.e. across different face identities).

|  |  | Frontal facing | Three-quarters | Variance |
|---|---|---|---|---|
| Trustworthiness | Frontal facing | - |  | .17 |
|  | Three-quarters | .89** | - | .15 |
|  | Full profile | .83** | .88** | .12 |
| Dominance | Frontal facing | - |  | .14 |
|  | Three-quarters | .86** | - | .12 |
|  | Full profile | .76** | .86** | .10 |
| Attractiveness | Frontal facing | - |  | .40 |
|  | Three-quarters | .97** | - | .41 |
|  | Full profile | .90** | .93** | .36 |

** $p < .001$, *$p < .05$, all $n = 64$.

**Supplementary materials**
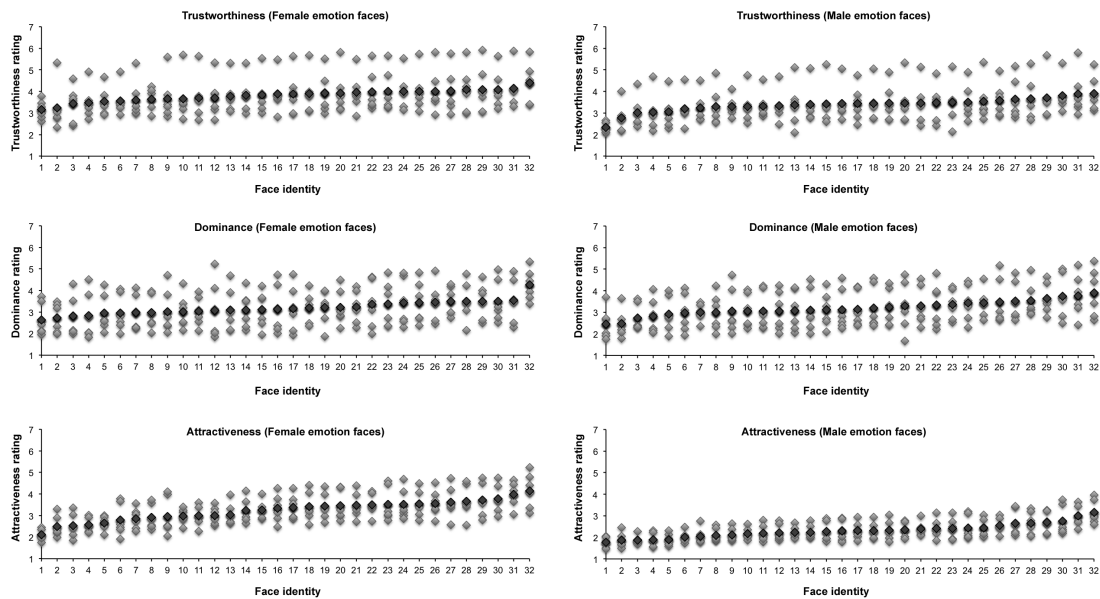


**Figure S1. Emotional expression variability.** Mean trustworthiness (top), dominance (middle) and attractiveness (bottom) ratings, plotted separately for female faces (left) and male faces (right). Each column represents a single identity, and each point represents a single emotional expression, collapsed across viewpoint (the overall mean rating for each identity is shown as a darker point). The horizontal axis represents the between-person variability (the face identities, ranked by their overall mean trustworthiness, dominance or attractiveness). The vertical axis represents the within-person variability in emotional expression.
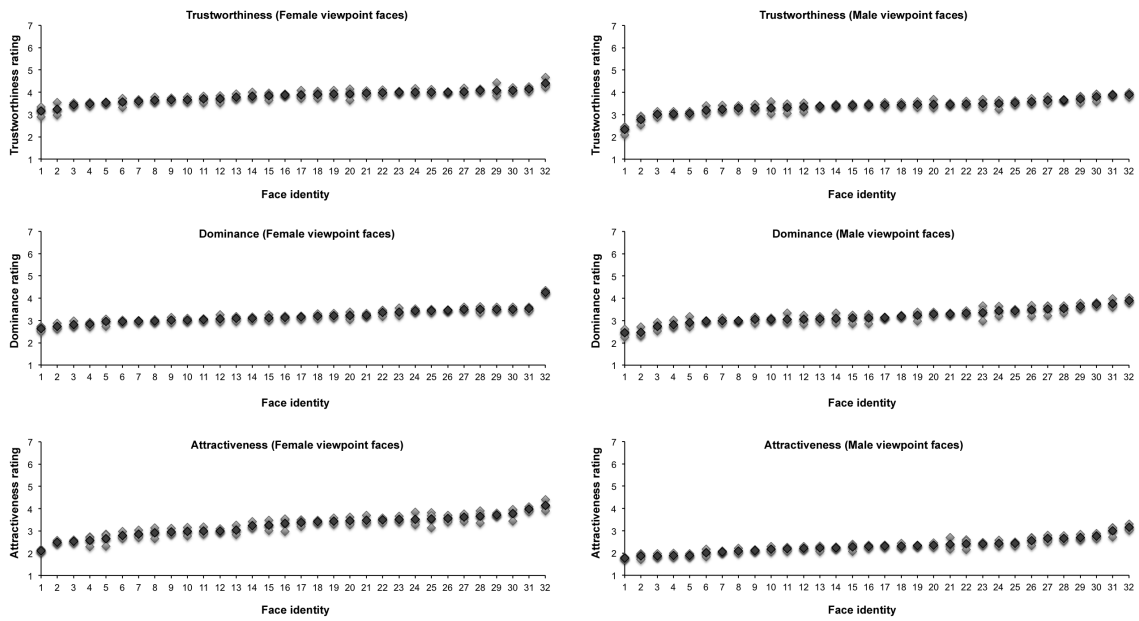
**Figure S2. Viewpoint variability.** Mean trustworthiness (top), dominance (middle) and attractiveness (bottom) ratings, plotted separately for female faces (left) and male faces (right). Each column represents a single identity, and each point represents a single viewpoint, collapsed across emotional expression (the overall mean rating for each identity is shown as a darker point). The horizontal axis represents the between-person variability (the face identities, ranked by their overall mean trustworthiness, dominance or attractiveness). The vertical axis represents the within-person variability in viewpoint.