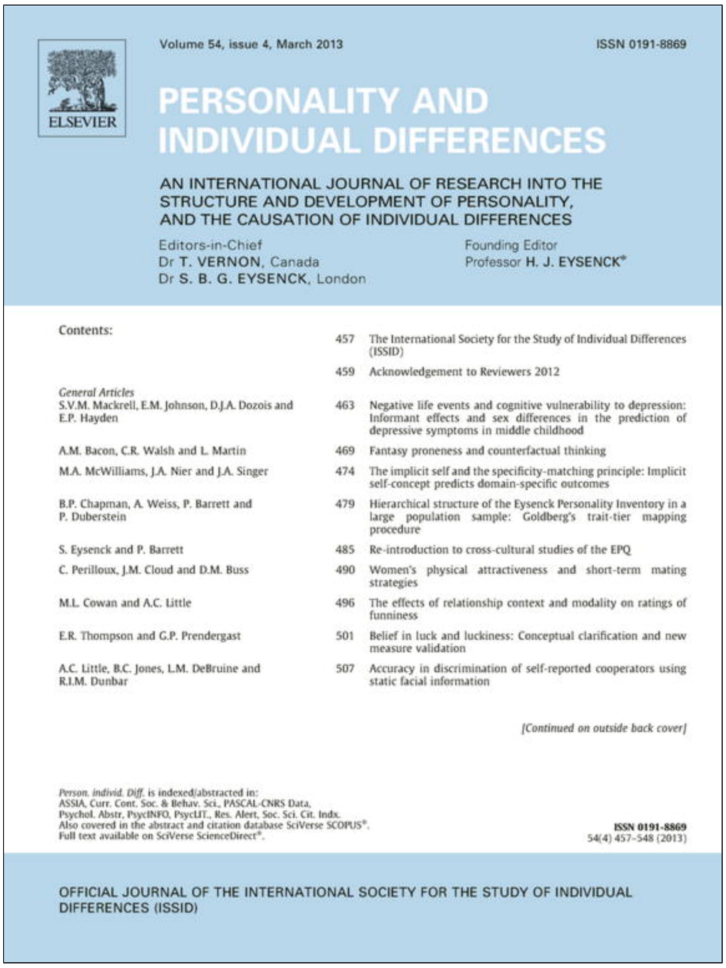

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Accuracy in discrimination of self-reported cooperators using static facial information

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ABSTRACT

People readily ascribe personality traits to others and believe that faces hold important guides to character. Here we examined the relationship between static facial appearance and self-reported cooperation/defection using the prisoner's dilemma ($N = 193$). Study 1 combined face images of those self-reporting they would be most and least likely to cooperate. The composites of cooperators were seen as more cooperative than non-cooperators. Study 2 demonstrated accuracy with ratings of individual faces. Masculinity of face shape was negatively related to self-reported cooperation for men, but not women. Further, ratings of smile intensity were positively, but not significantly, related to self-reported cooperation. Overall, individuals appear able judge the potential of others to cooperate from static facial appearance alone at rates greater than chance.

1. Introduction

In evolutionary terms there is a selective advantage in detecting cooperative partners both for social exchange and mate choice. Individuals who indiscriminately choose social partners are prone to large costs if those partners subsequently choose to 'cheat' on them. Cheating here refers to a social partner behaving in a manner that results in a gain to themselves at the expense of a particular individual and hence synonymous with non-cooperation. In general terms, those trying to detect potential cooperation are receivers and are under selection to predict the behaviour of signallers, who display their status as cooperators or non-cooperators. Signallers are also under selection to manipulate receivers and so their signals may be honest or dishonest (see e.g., Krebs & Dawkins, 1984). Under these pressures we can expect honest signals to evolve where accuracy leads to a benefit for both signallers and receivers and dishonest signals to evolve where inaccuracy benefits signallers but not receivers. In humans, cooperation can generally be thought of as a non-zero sum game. Because interaction can be beneficial to two cooperators, we might expect individuals to honestly advertise their capacity for cooperation. However, if an individual signals their propensity for cooperation perfectly then they cannot acquire the benefits of exploiting others and because of their predictability they can be easily exploited themselves (Andrews, 2002). An evolutionary view may then predict that there should be some, but not perfect, accuracy when observers predict the behaviour of others because of pressures to find other cooperators, be seen as a cooperator but also avoid exploitation.

People are indeed somewhat accurate in some personality attributions. Passini and Norman (1966) examined small groups who, without verbal interaction, were asked to rate each other. They found significant correlations between self and others' ratings for extraversion, conscientiousness, and openness and other studies show similar effects (Albright, Kenny, & Malloy, 1988). Accuracy in judgements of these personality traits can also be seen using photographs of static faces (e.g., Little & Perrett, 2007).

For traits more closely tied to cooperation, Berry and Brownlow (1989) found that ratings of male babyfacedness, how closely a face resembles an infant face, were predictive of self-reported approachability and warmth. Babyfacedness is perceptually associated with these traits suggesting agreement between self- and other-rated traits. When composite faces (single images that reflect a combination of multiple faces) are made of those scoring high and low on Machiavellianism and psychopathy questionnaires, the image made from high scoring participants was rated higher on the trait than the other image (Holtzman, 2011). Other studies have demonstrated that facial width scaled for face height, a measure correlated with perceived aggression (Carre, McCormick, & Mondloch, 2009), is related to self-reported dominance and, relating to real behaviour, aggressive behaviour in sport (Carre & McCormick, 2008). Again addressing behaviour,

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individuals with faces rated as having low perceived honesty are more likely to volunteer for experiments that involve them deceiving others than people who are judged from facial photographs to look more honest (Bond, Berry, & Omar, 1994). These studies all suggest that there is accuracy in judging traits potentially related to cooperation, such as warmth or aggression, from static faces.

Research has addressed accuracy in judging cooperativeness directly from richer stimuli than static face images. After brief social interaction, in which participants were allowed to mingle, participants could predict whether a person would cooperate or defect in a subsequent prisoner's dilemma game (Frank, Gilovich, & Regan, 1993). Also, using video recordings, self-rated altruists (scoring high on an altruism questionnaire) are judged as more helpful than non-altruists (Brown, Palameta, & Moore, 2003; Fetchenhauer, Groothuis, & Pradel, 2010; Oda, Naganawa, Yamauchi, Yamagata, & Matsumoto-Oda, 2009). In one study, smiling behaviour was positively linked to self-reported altruism (Brown et al., 2003).

Focusing on static appearance and cooperation, using photos taken at the moment of cooperation or defection, the faces of those who defect are more easily remembered in recognition tasks by unfamiliar participants suggesting a difference in the physical appearance of cooperators and defectors (Yamagishi, Tanida, Mashima, Shimoma, & Kanazawa, 2003). Potentially, this difference in face appearance may reflect emotional leaks at the point of defection. Another study has demonstrated attention is drawn towards the photos (again taken while playing) of non-cooperators (Vanneste, Verplaetse, Van Hiel, & Braeckman, 2007). Further, one physical measure is also related to cooperation, facial width scaled for face height has been found to be positively correlated to exploitative behaviour in a trust game as well as affecting attributions of trustworthiness (Stirrat & Perrett, 2010). Together, while not addressing accuracy, these studies point to potential emotional or structural correlates of cooperation in static faces.

In terms of static facial appearance, there are two likely components that could contribute to accuracy in judging cooperative tendencies: expression and structure. Here we focus on smiling and masculinity as cues to cooperation. People associate smiling faces with trustworthiness (Lafrance & Hecht, 1995). From static facial appearance there are two reasons why smiling may be associated with a tendency to cooperate. Firstly, individuals who are more cooperative may be more likely to smile, even subtly in posed neutral photographs. Smiling in men is associated with low social dominance (Hareli, Shomrat, & Hess, 2009) and, related to this, men with high testosterone, associated with dominance (Mazur & Booth, 1998), produce smaller smiles when asked than do men with lower testosterone. The tendency to produce smiles may then link to behavioural dispositions. Following this, expression use may also change the appearance of a face. For example, continued smiling may result in more permanent facial lines or change the size or resting position of underlying facial muscles (Malatesta, Fiore, & Messina, 1987). Alongside expression, face structure may be related to behaviour. Masculinity, like smiling, is related to testosterone, because testosterone is proposed to be responsible for the development of masculine facial traits (Enlow, 1982). Masculine face shape is seen as less trustworthy (Perrett et al., 1998) and this might reflect associations among masculinity, testosterone, and negative social behaviour (Mazur & Booth, 1998). We then predict that smiling would be positively associated and masculinity negatively associated with an individual's cooperative tendencies.

Previous studies suggest that individuals are able to detect traits that may relate to cooperation and that some face measures do predict tendency to cooperate. The current study aimed to directly examine the accuracy of perception of self-rated cooperativeness from static faces (Study 1 and 2) as well as examine how smiling and facial masculinity relate to self-reported cooperation as potential cues for accurate perception (Study 2). Potentially there are sex differences for both raters in detecting cooperative individuals or in targets how easy it is to detect cooperative tendencies. Given that cooperation is common between men and women and important to both, it appears likely that equivalent effects will be seen.

2. Study 1: judging self-reported cooperation from composite faces

In Study 1 we created composite images of individuals self-rating themselves as cooperators or non-cooperators. Composites are useful as characteristics common to the individual faces combined in composites are maintained and highlighted, while idiosyncratic variations that are not common to the set are 'averaged out'.

2.1. Participants

Target participants to be rated were 103 females (aged 17–29, M = 20.68, SD = 2.15) and 90 males (aged 17–30, M = 21.46, SD = 2.79). All target participants were selected for reporting to be <31 years of age and were of white European appearance (a range of participants with different ages and ethnicities were recruited but restrictions were applied). A different set of 35 participants (23 females, aged 16–24, mean age = 19.6, SD = 2.3) acted as raters who completed the rating study over the internet and were volunteers following a link from a research website.

2.2. Photography

Front-on colour facial photographs were taken of target participants under standardized diffuse lighting conditions against a constant background. Participants were asked to pose with a neutral expression. Photographs were retaken if expression was evident and were taken by a mixture of male and female photographers. Images were captured via remote camera settings activated from a computer out of view of the person photographed. Participants removed spectacles and men were clean shaven in appearance.

2.3. Measuring self-reported cooperation

After photographs were taken, participants were presented with the following text representing the classic prisoner's dilemma (Axelrod, 1984): "Imagine a situation where you and an associate have committed a crime. You have been caught but the evidence is flimsy. You and your partner in crime are taken to separate rooms and interrogated individually and each are offered a deal by the police. If you give evidence against your associate you can walk free but your associate will receive 20 years in prison. However if your associate also chooses to give evidence against you then you will both spend the next 10 years in prison. If on the other hand you both remain quiet you would both only spend 3 years in prison. Should your associate give evidence against you while you remain quiet it is you who will spend the next 20 years in prison."

This was presented with: "Given this situation, rate how likely (from 1 to 6) you would be to give evidence against your associate or remain quiet." and a 6-point Likert scale with numbers 1–6, (1 = "give evidence against your associate", 6 = "remain quiet").

2.4. Making composite face images of self-rated cooperators and non-cooperators

The 15 highest (cooperators) and 15 lowest (non-cooperators) scorers on the self-reported cooperation question for target men and women were selected to make the composites. Where individuals were tied leading to more than 15 faces, tied participants were selected at random. For the non-cooperator female face, this meant 1 woman was chosen from 13 tied scoring "3" and for the cooperator face 15 women were chosen from 30 scoring "6". For men, there were 15 individuals scoring either 1 or 2 and no random selection was needed. For the cooperator group, 15 of 36 men scoring 6 were randomly selected. Fifteen faces was deemed sufficient to capture the average configuration of cooperators/non-cooperators as the perception of individuality/distinctiveness changes little after 6 images (Little & Hancock, 2002). The mean difference in scores between the highest 15 and lowest 15 scorers was 4.40 for men and 4.27 for women. The scores of the cooperators and non-cooperators were significantly different from each other for both women ($t_{28} = 27.84$, $p < .001$) and men ($t_{28} = 33.61$, $p < .001$).

The composite faces were created using specially designed software (Tiddeman, Burt, & Perrett, 2001). Key locations (174 points) were manually marked around the main features (e.g., eyes, nose, etc.) and the outline of each face (e.g., jaw line, hair line). The average location of each point in the 15 faces for each composite was then calculated. The features of the individual faces were then morphed to the relevant average shape before superimposing the images to produce a photographic quality result. For more information see Tiddeman et al. (2001).

To create a test of the ability to discriminate between cooperators and non-cooperators based on shape only we used 10 pairs of composite face images (5 male and 5 female base faces). Each pair comprised of one cooperator and one non-cooperator version of the same face (see Fig. 1). The base faces were made by creating an average image made up of 5 random individual facial photographs from the pool of photographs described above (see e.g., Benson & Perrett, 1993; Tiddeman et al., 2001). Faces were transformed on a cooperative dimension using the linear shape difference between the cooperator and non-cooperator composite appropriately for each sex (following Perrett et al., 1998). Transforms represented ±50% the difference between these two composites (images differed by 100% in shape, reflecting the original difference between composites). Each face was transformed along the cooperation axis by the same amount and faces retained their identities. Composite images were not made symmetric to maintain any consistent asymmetries present in the images. Examples of transformed images can be seen in Fig. 1.

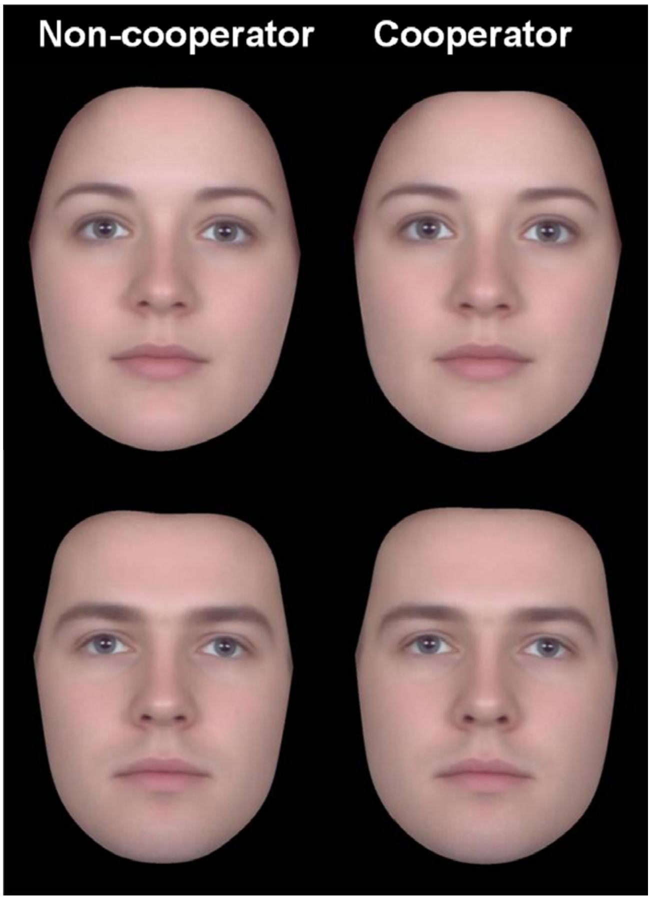

Fig. 1. Transformed composite images representing the shape of non-cooperators (left) and cooperators (right) based on self-assessments of cooperation in the prisoner's dilemma.

2.5. Procedure for judgements

Participants were first asked their age and sex. They were then presented with the 10 forced-choice paired image trials (5 male pairs, 5 female pairs, choosing between cooperator and non-cooperator faces). Participants were asked: "Imagine you are playing a game where both players have to cooperate in order to win. You are asked to choose between two individuals to play with. Please choose who you think is most likely to COOPERATE for the following pairs of faces" and alongside each face pair: "Please indicate which person you think would be most likely to COOPERATE". The trials were presented in random order with side of presentation also randomised. There was no time limit for the judgements.

2.6. Results

Each participant generated two scores, one for female faces and one for male faces. If participants chose a face that was transformed to appear more cooperative, we classed this as a correct choice. Correct scores out of 5 pairs were converted to percentages (100% = all correct, 0% = none correct). One sample *t*-tests against chance (50%) revealed that participants were more accurate than chance at correctly guessing both the female (M = 62.9%, SD = 20.1, $t_{34} = 3.79$, $p = .001$) and the male cooperators (M = 61.1%, SD = 23.2, $t_{34} = 2.84$, $p = .008$). These scores were averaged to provide a single combined accuracy score, for which participants were also more accurate than chance (M = 62.0%, SD = 14.5, $t_{34} = 4.89$, $p < .001$). Mean scores can be seen in Fig. 2.

A mixed model ANOVA with accuracy scores as the dependent variable, sex of face (male/female) as a within-participant factor, and sex of participant as a between participant factor revealed no significant effect of sex of face ($F_{1,33} = 0.01$, $p = .960$), no significant effect of sex of participant ($F_{1,33} = 0.34$, $p = .564$), and no interaction between these factors ($F_{1,33} = 1.24$, $p = .274$). A

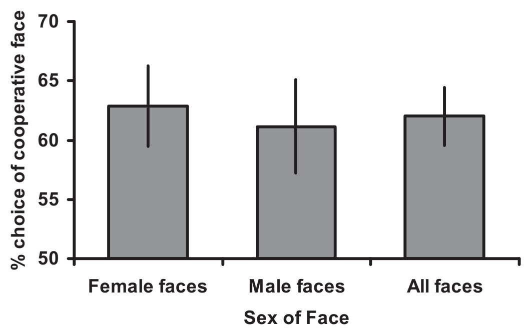

Fig. 2. Percent choice of the cooperator faces when asked to choose the most cooperative appearing face (±1 SE of mean).

correlation revealed no significant relationship between accuracy scores for male and female faces ($r = -.108$, $p = .537$).

3. Study 2: perceived trust, smiles, measured facial masculinity and self-rated cooperation in individual faces

In Study 2, we examined the relationship between other-rated trust and target self-rated cooperation using unmanipulated faces. We additionally addressed whether faces traits related to smiling and masculinity predicted self-rated cooperation. People trust smiling over non-smiling individuals (Scharlemann, Eckel, Kacelnik, & Wilson, 2001) and so we predicted that self-rated cooperators may produce subtle smiles or else have physiognomy that approximates smiling more than non-cooperators. Facial masculinity is linked to perceptions of low cooperation (Perrett et al., 1998) and so we predicted that if this perception is accurate that cooperators would have more feminine face shapes that non-cooperators.

3.1. Participants

Target participants to be rated were the same as in Study 1. A different set of 10 participants (5 women, 5 men, aged 22–53, M = 27.00, SD = 9.66) acted as raters. All participants were tested in the laboratory.

3.2. Photography and self-reported cooperation

These were taken from Study 1.

3.3. Measuring masculinity

Masculinity measures were taken from points marked on facial features used in previous studies (Little et al., 2008) and can be seen in Fig. 3. In total, four measurements were taken: Cheekbone Prominence, Jaw Height/Lower Face Height, Lower Face Height/Face Height, and Face Width/Lower Face Height. These measurements have been found to be sexually dimorphic in previous studies (Little et al., 2008). To compute an overall measure of masculinity, these variables were entered into a discriminant analysis to discriminate sex of face. The sexes differed based on classification (Wilks' Lambda = .723, chi square = 61.62, DF = 4, $p < .001$). Classification was correct/incorrect for females 72/31 and males 68/22. Probability of being allocated to the male group was used as a measure of masculinity. High scores reflect greater masculinity.

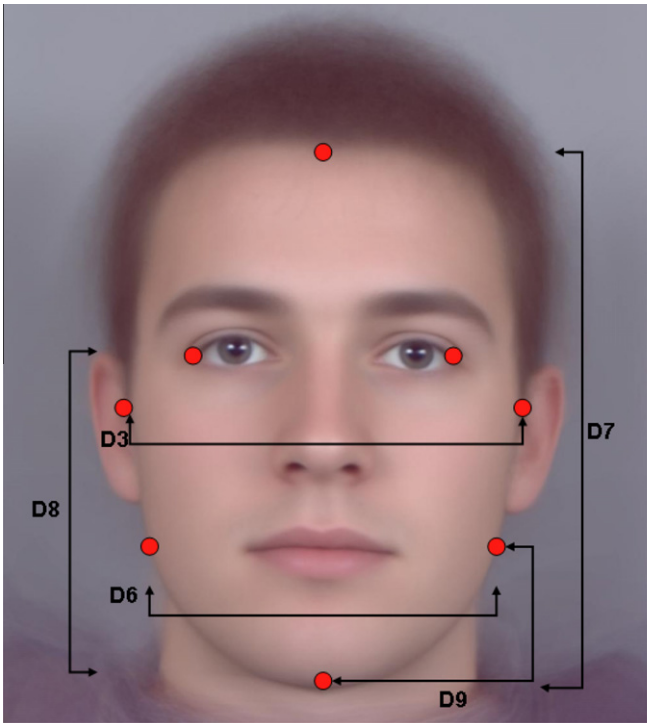

Fig. 3. Masculinity was measured by measuring distance between specific points and calculating four ratios: Cheekbone Prominence (D3/D6), Jaw Height/Lower Face Height (D9/D8), Lower Face Height/Face Height (D8/D7), and Face Width/Lower Face Height (D3/D8). Where there are two points for a height distance measure, the average height was used. Numbers assigned are consistent with previous studies.

3.4. Procedure for trustworthiness and smiling judgements

Participants were asked to rate the 193 faces for trustworthiness with the following question: "How TRUSTWORTHY is the person in this picture?" Ratings were on a 7-point scale (1 = very low, 7 = very high). Following this, participants were asked to rate the faces for intensity of smile with the question: "How much of a SMILE is present on the face?" Ratings were on a 7-point scale (1 = not smiling, 7 = smiling). Faces were presented to participants on computer screen individually and in a random order. There was no time limit for the ratings.

3.5. Results

3.5.1. Reliability of ratings

Reliability analysis using coefficient alpha revealed high agreement amongst judges for ratings of trustworthiness (alpha = .987) and smile intensity (alpha = .986).

3.5.2. Main analysis

Sex differences for target participants were analysed using independent samples *t*-tests. These revealed that target men and women did not differ in self-perceived cooperation (women mean = 4.53, SD = 1.47, men mean = 4.64, SD = 1.56, $t_{191} = 0.53$, $p = .596$), women were perceived as more trustworthy than men (women mean = 3.71, SD = 0.67, men mean = 3.48, SD = 0.61, $t_{191} = 2.45$, $p = .015$), women and men were not significantly perceived to be smiling to different extents (women mean = 3.38, SD = 0.98, men mean = 3.14, SD = 0.92, $t_{191} = 1.76$, $p = .080$), and that men had higher measured masculinity than women as determined by probabilities of classification as male (women mean = 0.36, SD = 0.22, men mean = 0.64, SD = 0.23, $t_{191} = 8.80$, $p < .001$).

Pearson product moment correlations revealed significant positive correlations between target self-rated cooperation and other-rated trustworthiness for both women ($r = .281$, $p = .004$) and men ($r = .211$, $p = .045$). The difference between these correlations was not significant ($Z = 0.51$, $p = .610$). Results remained the same when data were not split by sex and sex entered as a covariate ($r = .248$, $p = .001$).

There was a significant negative correlation between target self-rated cooperation and target measured masculinity for men ($r = -.236$, $p = .025$) but not women ($r = .003$, $p = .975$). The difference between these correlations approached significance ($Z = 1.66$, $p = .097$). This relationship was close to significant when data were not split by sex and sex entered as a covariate ($r = -.130$, $p = .073$).

There was a close to significant positive correlation between target self-rated cooperation and other-rated smile intensity for women ($r = .172$, $p = .083$) but not men ($r = .095$, $p = .375$). The difference between these correlations was not significant ($Z = 0.54$, $p = .589$). A close to significant positive correlation was seen when data were not split by sex and sex entered as a covariate ($r = .136$, $p = .061$).

A regression analysis entering target measured masculinity, other-rated smile intensity, and sex to predict self-rated cooperation revealed a close to significant overall model ($F_{3,189} = 2.46$, $p = .064$) and close to significant positive relationships for both measured masculinity (beta = −.148, $p = .066$) and smile intensity (beta = .139, $p = .055$). The relationship for sex was not significant (beta = .128, $p = .115$).

4. Discussion

The results here suggest that individuals can to some extent accurately guess the likelihood of cooperation of an unknown individual based only on static cues from facial appearance. Study 1 demonstrated that for both men and women, the composites of individuals indicating a higher likelihood to cooperate were seen as more cooperative. We found equivalent effects for assessing cooperativeness both in male and female targets and male and female raters, consistent with the notion that the detection and display of cooperativeness is equally important across sex. Study 2 demonstrated that accuracy was also evident when individual unmanipulated faces were rated for trustworthiness. For both men and women, those indicating they were more likely to cooperate were rated as more trustworthy than those indicating they would be more likely to defect. Other ratings in Study 2 suggested structural masculinity and smiling (as seen in neutral faces) were associated with inclinations to cooperate. Masculinity of face shape was negatively related to self-reported cooperation for men but not women. More feminine-faced men reported being more likely to cooperate than masculine-faced men. For both men and women, ratings of smile intensity were positively, but not significantly (regression $p = .055$), related to self-reported inclination to cooperate. While not significant, those with greater smile intensity self-reported being more likely to cooperate. Although we used self-reports in our study, we note that questionnaire scores of altruism correlate with measures of actual cooperative behaviour (Brown et al., 2003; Eckel & Grossman, 1996).

In Study 1 people were able to identify cooperators from defectors about 12 percentage points greater than chance (50%) and in Study 2 ratings of trustworthiness explained about 6% (r^2 for men and women = 0.056) of the variance in self-rated cooperation. Together the studies suggest that people can detect likelihood to cooperate but that such detection is not perfect. Indeed, limited accuracy might be predicted given a potential arms race between receivers trying to detect potential cooperation and signallers displaying their status as cooperators or non-cooperators (Krebs & Dawkins, 1984). Our data are consistent with ideas that the face may be an honest signal. Such an honest signal may have evolved to benefit both signallers and receivers by allowing cooperators to find each other in a population and reap the benefits of cooperation (Frank, 1988). Alternatively, the face may not necessarily be a signal of cooperation produced by the signaller and accuracy may depend on selection pressures on observers to find cooperators for cooperation or exploitation. We note here then that we perhaps deal with only subtle cues rather than produced signals.

Measured facial masculinity was negatively related to self-rated cooperation here in men but not women, suggesting that masculinity is one aspect of facial physiognomy that can be used to predict cooperation, at least in men, consistent with masculinity being negatively related to perceived cooperativeness, (Perrett et al., 1998). From neutral faces, perceived smiling intensity was weakly associated with self-reported cooperation. This effect was not significant (from regression, two-tailed $p = .055$), though we predicted this positive relationship (one-tailed $p = .028$). Self-rated cooperators may then produce subtle smiles even when asked to pose with a neutral expression or else have developed a physiognomy that approximated subtle smiling more than non-cooperators, for example, through expressive tendencies influencing the resting appearance of facial muscles (Malatesta et al., 1987). Both effects may reflect that factors such as testosterone, related to dominance, influences both smiling behaviour and face shape.

The current studies used static faces with posed neutral expressions. These images represent only a snapshot of the information available when deciding to cooperate with someone. It is possible that asking participants to pose with a smile or capturing video footage would reveal more powerful effects of emotional cues like smiling. Additionally, we focused on one type of expression and one type of structural information. Given there may be interesting effects beyond smiling and masculinity, future studies can usefully examine other expressions, such as fear or disgust, and other structural traits, such as particular trait sizes or shape or variables such as age. The effect of smiling was not significant here and future studies can also further address the relationship between smiling and the tendency to cooperate. We also addressed self-rated cooperation and it would be interesting to examine whether similar effects hold in situations involving real-life cooperative decisions.

In conclusion, the current studies demonstrate that individuals can judge the potential of others to cooperate from facial appearance at rates greater than chance. Potentially, such accuracy may reflect pressures on cooperators to find other cooperators or selection to identify cooperators for possible exploitation.

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