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The value of a smile: Game theory with a human face

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Abstract

Many economists and biologists view cooperation as anomalous: animals (including humans) that pursue their own self-interest have superior survival odds to their altruistic or cooperative neighbors. However, in many situations there are substantial gains to the group that can achieve cooperation among its members, and to individuals who are members of those groups. For an individual, the key to successful cooperation is the ability to identify cooperative partners. The ability to signal and detect the intention to cooperate would be a very valuable skill for humans to posses.

Smiling is frequently observed in social interactions between humans, and may be used as a signal of the intention to cooperate. However, given that humans have the ability to smile falsely, the ability to detect intentions may go far beyond the ability to recognize a smile. In the present study, we examine the value of a smile in a simple bargaining context. 120 subjects participate in a laboratory experiment consisting of a simple two-person, one-shot "trust" game with monetary payoffs. Each subject is shown a photograph of his partner prior to the

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game; the photograph is taken from a collection that includes one smiling and one non-smiling image for each of 60 individuals. These photographs are also rated by a separate set of subjects who complete a semantic differential survey on affective and behavioral interpretations of the images.

Results lend some support to the prediction that smiles can elicit cooperation among strangers in a one-shot interaction. Other characteristics of faces also appear to elicit cooperation. Factor analysis of the survey data reveals an important factor, termed "cooperation", which is strongly related to trusting behavior in the game. This factor is correlated with smiling, but is somewhat more strongly predictive of behavior than a smile alone. In addition, males are found to be more cooperative, especially towards female images, whereas females are least cooperative towards female images. © 2001 Published by Elsevier Science B.V.

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1. Introduction

Imagine two persons facing one another for the first time in a social exchange, where there are potential gains to both parties. They know nothing about one another, but each has to make a decision and those decisions will jointly affect their payoffs. How does each anticipate the other's actions? How does one judge whether a partner is trustworthy or predict if trust will be reciprocated?

Strategic behavior involves actors choosing strategies contingent on the anticipated actions of others. Actors forecast the choices of others based on a vector of characteristics, which can be either inherent or intentional. Clearly actors embody inherent characteristics, such as gender, ethnicity, or age, that signal a type. Individuals display additional signals through attire, language, and facial expressions. Both inherent and intentional signals provide information and influence strategic choice.

Humans perform many actions, purposively taken with full knowledge of their consequences, which appear to be "irrational"; i.e., if they did not perform these actions, they would be better off, at least in the short term. In particular people often put themselves in a position where they must rely on another person to reciprocate a potentially costly trusting move. Examples include ordering software over the internet, leaving an automobile with a valet service, or buying a bottle of fine wine at a new wine shop. In each case we turn over something of value (a credit card number, a car or money) expecting to receive something in return, but at the same time risk exposing

ourselves to possible exploitation by "cheaters". The Internet firm may credit our account and never send the software. The valet may abscond with the car. The wine may be ruined, having been improperly stored. But people routinely trust others and successfully avoid cheaters. How?

This paper focuses on a cue that may affect the beliefs held by actors playing a simple game, and affect their willingness to risk an initial trusting move. We argue that the facial expression of a counterpart contains information that is used by an actor in formulating beliefs and subsequent actions. This research presents findings from experiments designed to test the effect of facial expressions on trusting behavior. We examine the effect of a smile on strategy choice in a simple bargaining game, while controlling for sex-pairings. Two questions are addressed: (1) Does smiling elicit trust among strangers? (2) Is there a difference between the sexes in assessing trust?

This is the first of a planned series of studies examining the social signaling of cooperation through facial expressions. Our purpose in this initial study is to discover any existing regularity in the relationship between the decision to trust and the facial characteristics of a partner. We isolate the effect of the facial expression of a partner on the decision to trust in a two-person, sequential game; facial expressions are predetermined, and constitute the controlled stimulus in our experiments. We do not examine actual attempts to signal cooperation – whether genuine or deceptive – on the part of partners to a potential exchange, and so do not test for subjects' ability to accurately signal or detect intentions. Plans for future research that will examine these issues are discussed in the final section.

2. Motivation

The tension between self-interest and the common good is most frequently studied in the context of prisoners' dilemma and public goods games. In these games, if individuals choose an individually rational strategy, collectively inefficient outcomes result. On the other hand, there are cooperative strategies that, if taken by both players, yield outcomes that make everyone better off. Choosing the cooperative strategy is risky, because cheaters can always take advantage of the cooperator. In a prisoner's dilemma game, defecting leaves the cheater better off and makes the cooperator worse off. In an exchange relationship the same is true. An actor who takes an initial move that trusts another to deliver on an exchange will be left worse off if that trust is not reciprocated. The key to a successful exchange is choosing a trustworthy

partner. If cooperators could easily identify cheaters, cooperation could flourish without the risk of a betrayal of trust.

Any mechanism designed to identify cooperators is likely to run into trouble because cheaters have a strong incentive to mimic cooperators. Consider a population of cooperators and defectors where cooperators are easily identified (assume they have a C on their foreheads), and cooperators can interact selectively with one another. Defectors on the other hand will be left to interact with one another, resulting in a lower payoff. Under such conditions it would pay defectors to mimic the co-operators' signal by marking a C on their foreheads. If defectors are perfect mimics, the feature looses all its power to signal a distinction, resulting in random pairings of cooperators and defectors.

This problem has been extensively discussed in the literature on evolution of animal signals, where optimal interacting strategies are seen as resulting from natural selection on both receivers and signalers. In general, theoretical biologists assume that for signals to be "evolutionarily stable" (i.e. for selection on signalers and on receivers to preserve both signaling and responding), signals must make the receiver act so as to favor the signaler. But this response must confer an advantage to the receiver as well. However, since signalers benefit from the signaling regardless of the reliability of the information that is signaled, there must be some selective check on signaling, and this is normally assumed to be a differential cost of signaling true and false information; i.e. signaling false information should be more costly than signaling veridically (Grafen, 1990; Zahavi, 1977; Hamilton & Zuk, 1982). This is cost is referred to as a *handicap*.

If we view smiling as a biological signal, a biologist would ask, what could act as a handicap in this case? At least two forms of handicap may be relevant to smiling. On one hand, it may be that producing a smile has a differential cost depending on the signaler's state, so that the balance of costs and benefits to the signaler inhibits indiscriminate smiling, and this in turn preserves the benefit of responding to the smile. Alternatively, smiles may act as "revealing handicaps", that is signals that are not costly to produce, but that have the effect of exposing the quality of the signaler to the receiver. For example, a receiver may be judging the quality of the signaler's teeth, and smiling exposes the teeth. Receivers may take a non-smiling individual as one who refuses to reveal her quality and hence discriminate against her. [3]

[3] The paradigmatic biological example of a revealing handicap is a feather arrangement or bare skin patch that allows the observer a better judgement of the potential damage due to parasites: individuals with high parasite resistance would develop particularly revealing feather arrangements or skin patches, forcing the rest to follow suit.

Thus, from a biological point of view, honest signals, such as true or Duchenne smiles (D-smiles) (Ekman, Friesen, & Davidson, 1990), will be maintained in a population either because smiling is differentially costly according some characteristic of the signaler, or because it reveals this characteristic to the receiver. In the context of this study, the relevant characteristic is "trustworthiness" or "cooperativeness" or a related trait that increases the benefit expected from trusting the counterpart.

There is at least circumstantial evidence that smiling is difficult to fake. Duchenne de Boulogne (1862) stated that "it will be simple for me to show that there are some emotions that man cannot stimulate or portray artificially on the face; the attentive observer is always able to recognize a false smile...", and Duchenne's views resonate with everyday subjective experience. Faking a D-smile is not possible for the majority of humans,[4] and this is consistent with the idea that it represents an honest signal; but the nature of its cost or the reason why it would be an uncheatable revealing indicator remain unknown.

Two experimental studies provide evidence that people can identify cooperators with some success. Frank, Ekman, and Friesen (1993) show that people are reasonably good at predicting the actions of their partners in a prisoner's dilemma game if subjects have observed one another for 30 minutes prior to making their decisions. Brown, Palameta, and Moore (1999) use video-clips of self-reported altruists and non-altruists and find that subjects do well in distinguishing between the two. They conclude that the two types send quite different non-verbal signals that other subjects are able to read. In short, there appear to be reliable signals that lead people to draw inferences about others.

What is the source of the signals used by individuals to facilitate prediction? An extensive literature on facial expressions contends that the human face is a rich source of social signals (Darwin, 1872; Ekman, 1982; Fridlund, 1994). While researchers debate whether the face leaks emotions or whether the face is purposively used to display social content, there is general agreement that humans are attuned to the messages emanating from the face.

A smile is a particularly common and effective signal and its function has been extensively studied (e.g. Ekman, Friesen, & Ellsworth, 1982, 1990). For example the ability to smile and to recognize a smile is developed very early in

[4] According to Frank (1988) only about 10% of the population are born with or later acquire voluntary control of all facial muscles, with actor Woody Allen a prominent example. Only those people are able to deliberately fake a D smile, others would require lengthy practice to gain voluntary control of these muscles.

life (Bruce & Young, 1998). Humans are able to recognize smiles at twice the distance of other facial expressions (Walk & Walters, 1988). Smiles can induce pleasure in the observer, or even in the smiler (Surakka & Hietanen, 1998).

Smiles are not just for show; they also have an impact on the behavior of others. For example, there is some evidence that newscasters' smiles can influence candidate choice (Mullen et al., 1986). Additional evidence shows that waitresses receive significantly larger tips when smiling (Tidd & Lochard, 1978). Finally, LaFrance and Hecht (1995) show that smiling generates leniency, with people who smile receiving lesser sentences for a given criminal conviction.

Observable characteristics other than smiles may also signal conventions for behavior. A characteristic such as sex or age may be correlated with the tendency to cooperate, and so may be treated as a signal of "type". For example, both sex and age are identifiable from still photographs (Zebrowitz, 1997), and so constitute readily perceived signals. Elderly persons are sometimes thought of as more cooperative (or vulnerable to cheaters). While women are considered the "cooperative sex", surveys of sex differences in bargaining games find women are sometimes more and sometimes less cooperative, contingent on the decision environment (Sell, 1997; Walters & Stuchlmacher, 1998; Eckel & Grossman, in press).

We report results of two studies designed to test whether people routinely use facial characteristics to forecast the actions of others. The first study, a questionnaire, elicits perceptions of a set of facial images. Both male and female subjects and facial images are used, and the images display either a smiling or neutral facial expression. In the second study, a decision-making experiment, we control the facial characteristics of a counterpart presented to a subject in a game with financial stakes. Subjects first observe a facial image of their "counterpart", taken from the same set of images. Subjects then play a simple bargaining game with in which they are asked to choose whether to trust the person depicted in the photograph.

3. Methods and results

3.1. Study 1: Questionnaire

3.1.1. Design

A questionnaire was designed to elicit perceptions of the facial features of pictures used in the decision-making experiment below. A subject observed

one black-and-white photograph and was then presented with 25 word pairs of opposite meaning as a paper and pencil task. All words were taken from Anderson (1968), and the pairs were matched using extreme ratings on his listing. (The word pairs were pre-tested in a group of 12 under a different task.) For each word pair subjects were asked to rate the photograph based on a three-point scale by choosing the word on the left, the word on the right, or "cannot tell". For example, consider the sad/happy wording pairing: if "sad" was chosen, it was coded as a rating of −1; if the subject selected "happy" the rating was 1; if the subject could not decide which word pair best fit, then a neutral rating of 0 was assigned. Table 1 lists the items included in the questionnaire and the percentage choosing the category.

Sixty photographic models were used, with two poses for each model: a smile and a neutral expression. Of the models, 47 were male and 13 were

Table 1
Word-pair items for questionnaire (percent choosing each alternative)

Word 1	Percentage	Cannot tell %	Percentage	Word 2
Good	25.8	58.3	15.8	Bad
Strong	42.5	40.8	16.7	Weak
Calm	45.8	32.5	21.7	Excitable
Kind	26.7	56.7	16.7	Cruel
Attractive	28.3	34.2	37.5	Unattractive
Trusting	21.7	39.2	39.2	Suspicious
Pleasant	42.5	40.0	17.5	Unpleasant
Tough	43.3	44.2	12.5	Fragile
Active	46.7	25.8	27.5	Passive
Friendly	48.3	34.2	17.5	Unfriendly
Cooperative	21.7	44.2	34.2	Competitive
Forgiving	18.3	59.2	22.5	Vengeful
Honest	25.0	53.3	21.7	Dishonest
Generous	18.3	58.3	23.3	Selfish
Trustworthy	29.2	46.7	24.2	Untrustworthy
Considerate	23.3	53.3	23.3	Inconsiderate
Sincere	23.3	60.8	15.8	Deceitful
Benevolent	23.3	60.8	15.8	Malevolent
Domineering	35.8	48.3	15.8	Submissive
Happy	40.8	40.0	19.2	Sad
Male	80.8	0.0	19.2	Female
Forthright	34.2	50.8	15.0	Scheming
Content	44.2	38.3	17.5	Frustrated
Secure	34.2	46.7	19.2	Insecure
Amiable	41.7	38.3	20.0	Hostile

Note: Because of rounding, not all rows sum to 100%.

female. The photographs were taken from the Psychological Image Collection at Stirling (PICS), Psychology Department, University of Stirling.[5] The 120 photographs were coded as either smiling or not smiling *for a given model*, and there is quite a bit of variation across models in the degree to which the facial expressions differ. While the faces we use are listed on the site as reflecting different facial expressions, no details are given about what the models were told when the photographs were taken.[6] One hundred and twenty graduate students and staff from a major British university participated in the questionnaire study (57 males and 63 females). The photographic images were assigned randomly to subjects, while the order of the word pairs was the same for all subjects. If all items on the questionnaire were answered with "cannot tell", the particular questionnaire was discarded, and the face assigned to a new subject.[7]

3.1.2. Results

Table 1 contains questionnaire items and aggregate ratings. We tested for and found no response bias in the questionnaire. For the analysis, word pair items were reordered in a consistent direction, and factor analysis, with a varimax rotation, was used to create scales across the word pair items. The three distinct factors with an eigenvalue above 1.0 were recovered. Five items are strongly correlated with the first factor, which we term *cooperative*: friendly/unfriendly, cooperative/non-cooperative, forgiving/unforgiving, happy/sad, and amiable/hostile. The second factor, which we term *trustworthy*, is strongly correlated with the items: honest/dishonest, trustworthy/untrustworthy, and sincere/insincere. The final factor, which we term *tough*, includes the items: strong/weak, tough/fragile, domineering/submissive, and secure/insecure. The factors identified in the analysis are intuitively appealing, and their importance is consistent with standard negotiation tactics (for example, see Foster, 1992).

The three factor loadings produce continuous measures that can be used in the analysis of behavior that follows. To give a sense of the structure of

[5] The URL for this site is: http://brl.rice.edu/JEP2001/index.html. The PICS database is a collection of images that has been used in psychological research. Previous research using these photographs was concerned with visual perception, memory and processing.

[6] We can be fairly certain that the subjects were not told to act as if they are signalling willingness to cooperate in a social exchange, however. The absence of the intention to signal may bias our results in the direction of a finding of no effect.

[7] Nine males and nine females (15% of all questionnaires) answered all questions with "cannot tell". Those questionnaires were discarded and 18 new subjects were used.

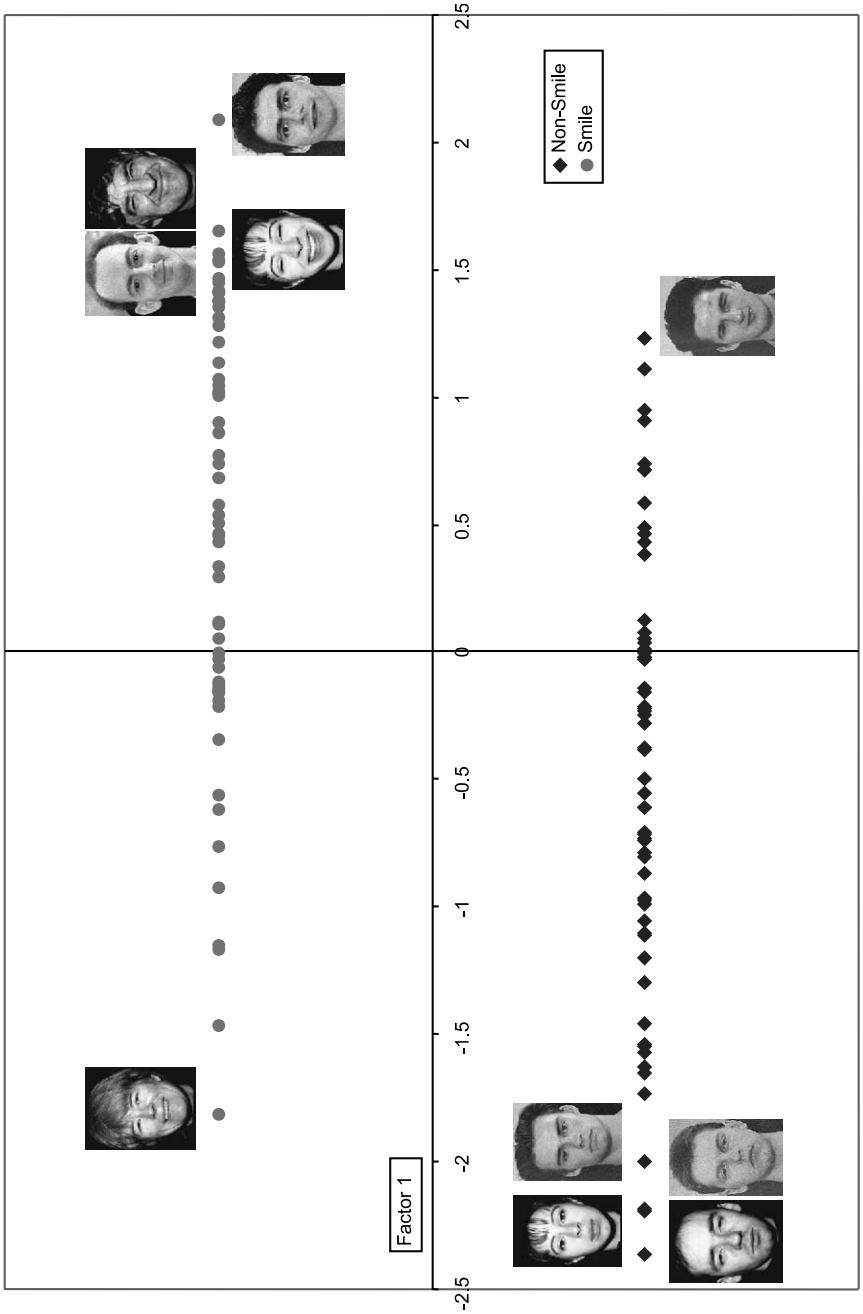

Fig. 1. Plot of factor 1 (cooperative) loadings by smiling and non-smiling images.

Factor 1, for example, we construct Fig. 1. The factor loading for *cooperation* is measured on the horizontal axis. Pictures coded as smiling are plotted above the axis, those that are coded non-smiling are below the axis. A t-test comparing the average factor loading for smiling versus non-smiling faces indicates a significant difference, with smiling photographs receiving higher scores ($t = 6.16$, $p < 0.001$). It is clear from the figure that Factor 1 is correlated with smiling ($\rho = 0.49$), but also incorporates other characteristics of the faces. While the ratings are not significantly related to the sex of the image or the rater, subjects apparently are able to perceive additional information in the faces apart from their smile. [8]

Several representative photographs are placed approximately at their positions on the Factor 1 distribution. Smiling and non-smiling faces that are rated highest and lowest on Factor 1 are shown. The photographs at the bottom left that are rated as non-smiling all exhibit dour expressions. Those at the top extreme right, and rated as smiling, exhibit inviting expressions. From these photographs it appears the factor loading does a fine job of discriminating between smiles and non-smiles. This is evident when comparing photographs of the same person; for example the non-smiling female at the bottom left is rated much lower than her smiling photograph at the upper right of the figure.

There is more to this factor than smiling and non-smiling images, however. Two photographs are included which are at the opposite ends of their distributions. The female model at the extreme left, but coded as smiling, is older and has a grimacing expression. The male model at the lower right is coded as non-smiling, but he carries a slight grin. While the images are coded correctly relative to their pair, it is clear that respondents perceive other attributes of these faces when viewed independently of each other.

These independent ratings indicate that there are at least three characteristics linked with the photographs. The first factor, which we have termed *cooperative*, is related to the presence or absence of a smile. The second and third factors are unrelated to a smile; instead they tap dimensions of *trust-*

[8] At the suggestion of a referee we estimated linear regression models for *cooperation* and *trustworthy* (as dependent variables) with the sex of the photograph, the age of the photograph (1 = under 21, 2 = 21–30, 3 = over 30), and the sex of the rater as independent variables. We find that neither the sex of the photo nor of the rater is significantly related to either scale. Age is also not significant in the *cooperation* equation, but is positively and significantly related to the *trustworthiness* index. However, the value is small: a one-point increase in the age scale is associated with an increase in the trustworthiness index of 0.015. Each model explained about 1% of the variance in the respective index. Details of the estimates are available on request.

worthiness and *toughness*. All three factors are viewed as capturing important attributes for actors in bargaining settings. We use this information in our second study.

3.2. Study 2: "Trust" game

3.2.1. Experimental design and justification

The second study is designed to investigate the extent to which subjects trust a smiling or non-smiling counterpart in a game with financial stakes. Survey information allows us to measure the subjective response of our subjects to the faces, but the impact on behavior of these perceptions is a separate issue. Economists predict that the incentive structure of the game should dominate any perceptions about a counterpart, while most psychologists would predict the faces should matter for behavior.

The experiment is a three-factor design ($2 \times 2 \times 2$) with factors consisting of the sex of the subject, the sex of the photograph, and whether the image is smiling. Each subject is randomly assigned one of the photographic images described above as a "counterpart" for a simple bargaining game. The subjects are led to believe that they are playing the pictured subject, but in fact play against a pre-programmed strategy, as explained below.[9]

While we prefer experiments where subjects are not deceived in any way, this design required that we present paired images for our stimulus. Experimental control over the content of the images necessitated some degree of deception. In our experiment we have fixed the signals being sent by the counterpart in order to maintain maximum control of the stimulus. Moreover, our design requires that we present these same faces for rating by different subjects. In both experiments, having one smiling and one unsmiling version of the same person adds experimental control.

As a rule, we agree that deception should be avoided in laboratory experiments. However, there are times when deception is both necessary and justified, as Bonetti (1998a,b), points out. We were careful in these experiments to meet the APA guidelines for deception and do not believe our results can be called into question based on its use. While the focus of our paper is not deception, but rather the effect of controlled stimuli on subjects' decisions, we detour briefly here to addressing common reactions among

[9] A version of the game can be found at http://brl.rice.edu/joep2001 or is available from the first author on request.

experimental economists to the issue of deceiving subjects. Three issues appear to be at stake.

First, there is the argument that deception will undermine the credibility of all experiments and so the validity of all experimental results. This view seems to have little empirical support. Bonnetti's survey suggests that even a strong expectation of deception rarely affects behavior relative to a control group, implying that even if subjects anticipate deception, their behavior will be unaffected. Many members of subject pools at most universities have participated in psychology experiments as a course requirement, so the subject pools used by experimental economists may already be contaminated to some extent by the expectation of deception. We attempted to minimize potential impact by conducting the experiment using a subject pool that is unlikely ever to participate in any other experiment, so their experience is unlikely to contaminate anyone else's subject pool. [10]

Second, deception can be used in a way that undermines the motivational basis for subjects (and this is the important point that Hey (1998) makes in his response to Bonnetti). It is crucial that subjects be motivated by the monetary incentives in experiments. If deception affects a subject's payoffs, preventing the subject from earning a maximal amount or otherwise breaking the linkage between actions and outcomes, then deception undermines the research results. This is where we draw the line in our own research. [11]

Third, the suspicion of deception may bias the results of the experiment itself. While, as mentioned above, there is little evidence to support this claim, neither we nor any other experimentalist can rule it out, as we have no way of removing the expectation of deception from our subjects' minds. We did our best to convince subjects that our claims were true, using the procedure described below. If subjects suspected deception, our best guess of the effect on their behavior is that it would make them less likely to trust, regardless of the stimulus, and, if anything, is likely to diminish the magnitude of any differences in response to stimuli. If there is a bias, it is in the direction of finding a null result.

Minor deception is sometimes necessary (or cost-effective) for achieving the desired level of experimental control over stimuli or feedback. In our experiment, control requires that subjects be presented with paired sets of

[10] If the reader believes that undergraduates read academic papers, some may come to know of the deception, and be affected by it.

[11] In our experiment deception does not harm subject's earnings. The deception component of this experiment did not break the linkage between the subject's action and the resulting outcome. Subjects were not misled about their own performance on the task, nor were decisions made that would deprive subjects of earnings.

faces. A single face is presented in two versions: one smiling, and one unsmiling. Without this control we cannot be certain whether our result is due to a smile, or due to some other difference between any two different faces. This led us to control the facial expressions by setting them ahead of time. Other experimental designs can be used to test related notions: we discuss some possibilities in a concluding section.

3.2.2. Procedure

The subjects are seated at a computer terminal for the duration of the experiment. Subjects participate in a variation on the Trust game (Berg, Dickhaut, & McCabe, 1995) shown in Fig. 2. The game is structured as follows. At the first node of the decision tree, the subject chooses between two alternatives. A move to the right ends the experiment: the subject earns £1.00, and her counterpart £0.50. A downward move passes the choice to the second player, who then faces a similar choice to end the experiment (giving the second player £1.25 and the first player £0.80) or to pass the move back to player 1. The first player then has a choice between £1.00 and £1.20 for each of the players. The unique subgame-perfect Nash equilibrium for this game has the first mover terminating the game at the first node.[12] However, there are gains to both players if there is trust and reciprocity. An initial "trusting" move is problematic because the second player has an incentive to quit at the second node, leaving the first player worse off; but if that trusting move is reciprocated, then both players are better off than at the Nash equilibrium.[13]

We take care to convince subjects of the credibility of the situation. At the outset, subjects are photographed using a small camera placed on top of the monitor, and this picture is shown to them before they view the counterpart's photograph. This is done to heighten the sense that subjects are playing against a counterpart at another computer in a separate room. Subjects are given detailed on-screen instructions including two examples with games without the trust-game incentive structure. Subjects then are shown a black-and-white photograph (stimulus face) of their apparent counterpart. Pho-

[12] The game is similar in structure to a centipede game (McKelvey & Palfrey, 1992).

[13] We acknowledge that higher incentives would have been preferable. A recent survey by Camerer and Hogarth (1999) indicates that beyond a minimal level, higher incentives rarely matter. While the level of incentives may affect variance (in our context, lessening the likelihood that any significant effects would be found), it rarely affects levels of behavior and is even less likely to affect comparative statics of treatments. In addition we note that Burham et al. (2000) find very similar overall levels of trust in a game with a similar structure and much higher incentive levels.

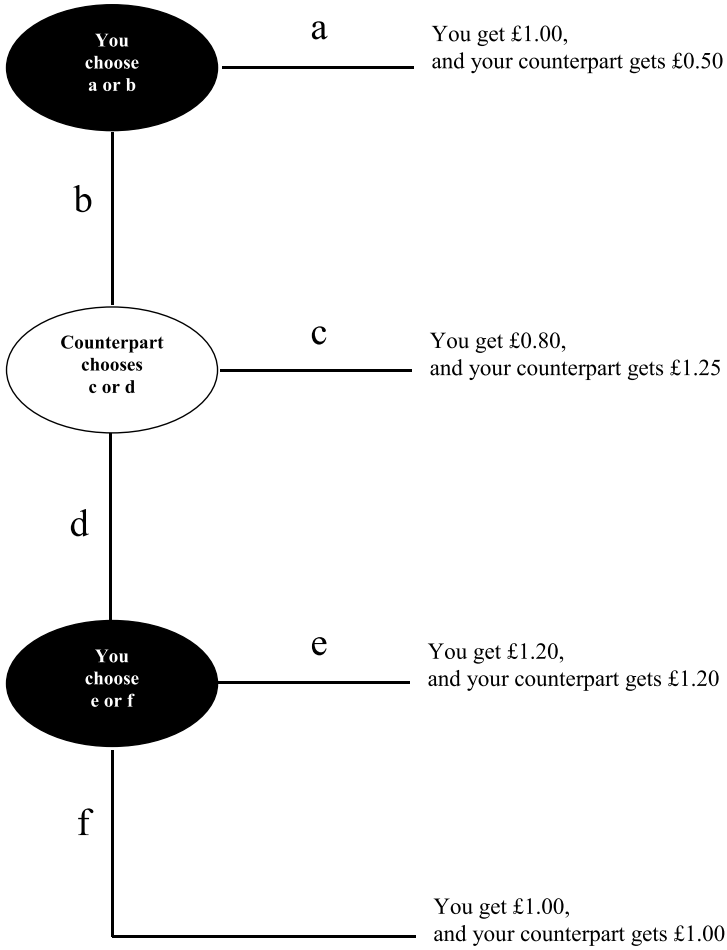

Fig. 2. Game used in the experiment.

tographs are visible as a smaller side picture while the game is played. After finishing the game subjects are asked to respond to an on-screen questionnaire. At the end of the questionnaire subjects are paid in cash the amount of money they earn (£1.20 or £1.00, depending on their choice).

In this game, subjects always are assigned to move first. The first move is the most interesting, as it indicates whether a subject declines to trust her counterpart by choosing the Nash equilibrium strategy, or trusts by passing to the counterpart. When subjects choose to pass, they are told to wait for their counterpart to make a decision. The computer is pre-programmed so

that the counterpart always chooses to reciprocate, then gives subjects the final choice.[14]

Subjects consisted of 120 graduate students and staff from a variety of Oxford University departments and colleges, solicited by email and by posters distributed to departments and colleges within the vicinity of the Department of Zoology. Subjects were required to book a specific slot to participate in the experiment and a reminder was sent a day before their experimental session. A total of 120 sessions (one subject per session) were conducted for this study. Of these subjects, a total of 58 were male (48.3%).

3.2.3. Results

Our principal conjecture is that smiling facial expressions act like a signal intended to induce a cooperative move.[15] In the analysis that follows, we analyze the value of a smile, then incorporate the factor analysis above into further analysis of the game.

Summary results are shown in Table 2.[16] Subjects trust smiling counterparts in 68.3% of decisions, and non-smiling counterparts in 55.0% of decisions. Using a one-tailed proportions test for paired samples, we can reject the hypothesis that the smiling and non-smiling counterparts are trusted equally ($t = 1.66$, $p = 0.051$).[17]

As shown in the bottom row of the table, male subjects chose to trust in 69% of decisions, while females trusted in 54.8% of decisions. The sex difference, while substantial, is not significant at traditional levels ($\chi^2(1) = 2.530$, $p = 0.112$). Male subjects show greater discrimination between smiling and non-smiling faces: males trust smilers in 79.3% and non-smilers in 58.6%

[14] The last choice, between terminal branches *e* and *f*, tests if subjects make rational choices, i.e. are able to differentiate between £1.20 (branch *e*) and £1.00 (branch *f*). Any subjects making the irrational choice of branch *f* were excluded from the analysis.

[15] See Eckel and Wilson (1997, 1998) for studies that make the same point in a somewhat different design.

[16] Of the 131 subjects participating in the study, three were excluded because of incomplete pairing (i.e. only one face of the pair was shown), four because of technical problems (computer or camera crashed) and another four because they made the irrational choice (branch *f*) (3% of subjects reacted irrationally). Of the remaining 120 subjects used for analysis, seven (6.2%) reported that the instructions were unclear. The average duration of experiment, including instructions and on-screen questionnaire, was about 8 min. Of 50 subjects who commented on the game only four (or 8%) stated that they believed their counterpart was not a real person.

[17] While paired samples tests are rare, such a test is entirely appropriate in this setting. Each model presented two different images, one smiling and one not smiling. Consequently we can pair the responses to the two images. This finding shows that smiles affect "trust" in this experiment. A standard *t*-test gives a similar result. See Kimmel (1957) on the use of one-tailed tests.

Table 2
Proportion of subjects choosing to trust by type of decision maker and characteristics of faces

Facial image	Decision maker		
	Male	Female	All
Male-neutral	0.565	0.583	0.574
Male-smiling	0.739	0.625	0.681
All male	0.652	0.604	0.628
Female-neutral	0.667	0.286	0.462
Female-smiling	1.000	0.429	0.692
All female	0.833	0.357	0.577
All neutral	0.586	0.516	0.550
All smiling	0.793	0.581	0.683
All faces	**0.690**	**0.548**	**0.617**

of decisions, while females trust smilers in 58.1% and non-smilers in 51.6% of decisions. The statistical reliability of this result is greater for males than for females ($\chi^2(1) = 2.90$, $p = 0.089$), and ($\chi^2(1) = 0.261$, $p = 0.61$, respectively).

The experimental design provides four subject/counterpart sex dyads. We can reject the hypothesis that all four sex pairings lead to equal degrees of trust ($\chi^2(3) = 6.649$, $p = 0.085$). Male subjects are more likely to trust female counterparts and females are more likely to trust male counterparts. However, the difference between same-sex dyads (male/male and female/female) and opposite-sex dyads (male/female, female/male) is not significant ($\chi^2(1) = 0.564$, $p = 0.453$). Finally, the sex of the counterpart has no significant main effect on trust overall ($\chi^2(1) = 0.222$, $p = 0.638$).

We conducted a multivariate probit regression analysis of the decisions by the subjects, incorporating all of the elements of the experimental design. Table 3 presents the results. The dependent variable in the regressions is bivariate and equal to one if the subject chose to trust the counterpart. The estimates predict the probability that a subject will make a decision to trust. Model 1 tests the effect of a smile on the decision to trust in a simple model that includes only an intercept and the variable Smile, which is equal to 1 if the face is coded as smiling, and 0 otherwise. The coefficient on Smile has the predicted sign, and is statistically significant using a one-tailed test at the 0.10 level. Model 2 permits the effect of a smile to vary according to the sex of the decision maker by interacting the variable "Smile" with sex. While the effect is positive in both cases, only for male subjects is it statistically significant. This indicates that men are more influenced by the smile of a counterpart.

Table 3
Probit regression results: dependent variable = trust

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	0.126	0.126		
	(0.162)	(0.162)		
	(0.439)	(0.439)		
Smile	**0.351**			
	(0.233)			
	(0.066)[a]			
Smile X		**0.692**	**0.631**	
Male subject		(0.309)	(0.360)	
		(0.013)[a]	(0.040)[a]	
Smile X		0.077	0.169	
Female subject		(0.279)	(0.323)	
		(0.390)[a]	(0.301)[a]	
Factor 1X				**0.467**
Male subject				(0.217)
				(0.016)[a]
Factor 1X				0.135
Female subject				(0.162)
				(0.202)[a]
Male subject with Male face			0.092	**0.424**
			(0.254)	(0.197)
			(0.714)	(0.031)
Male subject with female face			0.731	**1.346**
			(0.466)	(0.512)
			(0.116)	(0.008)
Female subject with male face			0.077	0.257
			(0.243)	(0.184)
			(0.720)	(0.161)
Female subject with female face			−0.453	−0.407
			(0.383)	(0.350)
			(0.236)	(0.245)
Log likelihood	−78.75	−77.15	−74.75	−73.51

Standard errors for coefficients shown in parentheses; *p*-values are in italics; bold indicates significant at $p \leqslant 0.10$.
[a] Indicates a one-tailed test.

Models 1 and 2 implicitly assume that all subject-pairings are the same. Model 3 includes the sex-pairings as dummy variables, to allow for heterogeneity across pairings. (Note that this specification requires that the intercept be dropped.) The coefficients and significance levels on the Smile variables are stable across the two models. Male subjects are more trusting with female faces, but female subjects trust female faces less than male faces. Using likelihood ratio tests, the hypothesis that men treat male and female faces the same cannot be rejected (i.e. a model that allows the two coefficients to be different does not account for significantly more of the variation in the

dependent variable than a model that constrains the coefficients to be the same, $\chi^2(1) = 1.82$, $p = 0.177$), but women are significantly less trusting of female faces ($\chi^2(1) = 2.70$, $p = 0.100$).

Perhaps it is not merely the counterpart's smile and sex that are interpreted as a signal of the intention to cooperate, but some other aspect of their faces. We conducted additional regressions, replacing the Smile with Factors 1–3. To our surprise, the inclusion of Factors 2 and 3 in the regression had no effect on its explanatory power (results not reported here). The coefficients were never close to statistical significance, and their inclusion did not affect the coefficients on the other variables. In Model 4 we replace Smile with Factor 1 derived in the previous section.[18] Consistent with the previous model, males are more responsive to the counterpart's smile than females. Once more, men are more likely to trust female faces, and women to trust male faces. In this specification of the model, we are able to reject the hypothesis of equal treatment of male and female faces for both men and women. (For male subjects, $\chi^2(1) = 3.34$, $p = 0.068$); for female subjects, ($\chi^2(1) = 2.92$, $p = 0.087$).

To provide additional intuition for these results, we calculate the probabilities of taking a trusting move based on the parameters from Model 4 for both male and female subjects. As the loading on the cooperative factor increases, the probability that males will select a trust move rises from 0.22 to 0.97. By contrast, the probability that females will take a trusting move slowly rises from 0.22 to 0.48.[19] The males appear to be more responsive to inviting faces, as measured by Factor 1, than females.

4. Discussion

The main results of this study are that: (1) smiling, at the margin, positively affects trust among strangers, (2) facial features can affect cooperation,

[18] We also ran regressions similar to Models 1 and 2 substituting Factor 1 for Smile, with similar results. Using a log-likelihood test we can reject that the four sex-pairings exhibit the same levels of trust, making Model 4 the appropriate specification. In addition, we tested for the effect of Factors 2 and 3 in these models; the coefficients on Factors 2 and 3 are never significant, and their exclusion does not affect the magnitude or significance of the other variables. For models 3 and 4, we also test for an interaction effect between the four sex pairings and Smile, and find no significant effect.

[19] These calculations use the Factor 1 interaction with the male or female subject and fix the additional parameter from Model 4 to be a same sex pairing. For example, when estimating the male probability, the parameters for the male by Factor 1 parameter was used as well as the male/male sex pairing parameter. Using opposite-sex pairings would result in more extreme differences between the sexes.

regardless of smiling, and (3) both males and females are more trusting toward members of the opposite sex. To our knowledge, ours is the first test of the effect of facial expressions on behavior in a controlled laboratory environment with financial stakes.

Smiling increases trust among strangers. Subjects were more likely to trust photographs of smiling persons than non-smiling photographs of the same persons. The result is significant in a one-tailed, matched-pairs proportions test, as well as in regression analysis. We interpret this to mean that subjects were able to detect a difference in facial expression, and that facial expression affected the subjects' beliefs about the trustworthiness of the counterpart represented by the facial image. Thus smiling appears to serve as an informative stimulus to elicit trusting behavior.

Our results are somewhat more convincing when we consider that several factors might bias our results toward a null finding. First, the photographs of counterparts were taken under artificial conditions unrelated to the experimental environment. As far as we know, the photographic models were simply instructed to display a particular expression "smile!", and were not told what their expressions would be used for. Most social signals are tied to a social context, but these photographic models were given no such context. It may well be that if the models knew their expressions would be a signal in a bargaining game, they would have offered facial expressions that could be interpreted more readily.

Second, there is considerable variability across smiles. Other than our questionnaire ratings, we made no attempt to directly rate the physical attributes of the smiles, or to categorize them as true or false smiles. This could be achieved by using the Facial Action Coding System (FACS) developed by Ekman and Friesen (1982). If smiles are effective signals, then true smiles should have a much stronger effect than false smiles.

Third, the use of still photographs biases the perception of the facial expressions. With still photographs, judgements are derived from permanent physiognomic features rather than transient muscle movements (e.g., facial wrinkles cannot be distinguished from wrinkles caused by muscle action), and the natural flow of behavior may be mutilated into meaningless units (Ekman et al., 1982). Social communication is 'a structure not of objects but of events'; therefore dynamic footage of facial expression may be a more appropriate means of eliciting naturalistic viewing patterns to expression-dependent facial features (Nahm, Perret, Amaral, & Albright, 1997).

Fourth, we have not considered the attractiveness of faces. Some images might be perceived as more attractive than others, regardless of whether they

are smiling. Lau (1982) found that smiling and sex had significant effects on attractiveness. Moreover, physical attractiveness has a powerful effect on perceptions of intelligence and predictions of success (Zebrowitz, 1997, Chapters 6 and 7), and is rewarded in the marketplace across a wide sample of professions (Biddle & Hamermesh, 1998; Hamermesh & Biddle, 1994). We plan an investigation of the effect of attractiveness on trust and other aspects of bargaining.

Finally, the questionnaire responses (study 1) make it clear that facial features other than smiling may be important in communicating intentions. Our first factor, which was most strongly correlated with trusting behavior, does more than differentiate between smiling and non-smiling images. It also captures something about the "niceness" of the photographic image. As we have labeled the factor, it appears to be an invitation to cooperate.

Another potential shortcoming of our study is its reliance on fictional counterparts. In future work we plan to implement an alternative design in which counterparts can freely send their own signal – a smile or frown. Since each subject controls the facial expression that is sent, we will no longer have the degree of control (two expressions for each face) that the current study provides. The experiment presented here controls one side of the signaling problem. Now that we have established the effect of a smile in a controlled setting we can move on to the more complicated design. [20]

Relating our results to others, we see that the overall level of trust is somewhat lower than that found in most other studies, though our restricted trust game is sufficiently different from other studies to make that comparison difficult. Our game gives subjects the option to trust their counterpart with 20% of their payoff, with the possibility of doubling the amount if the trust is reciprocated; i.e., subjects give up £0.20 for a potential gain of an additional £0.20. In other studies, subjects choose the amount they wish to entrust their counterpart. In a study where the trusted amount triples in value, Berg et al. (1995) find that 87.5% of subjects trust their counterparts with at least 20% of their endowment; in a face-to-face design, Glaeser, Laibson, Scheinkman, and Soutter (2000) double the trusted amount, and find a somewhat higher level of trust among Harvard University undergraduates. Both of these studies have average payoffs about five times the level of our study.

[20] Both referees suggested design variations similar to those we had planned.

While Berg et al., does not examine individual differences in amounts entrusted, the Glaeser et al., study tests for sex differences (among other things) and finds no significant differences in behavior of women and men or across sex pairings. Croson and Buchan (1999) finds that while women and men are equally likely to trust an anonymous partner, women are more likely to reciprocate trust. One similar study (Burnham, McCabe, & Smith, 2000) finds very similar overall levels of trust in a somewhat more complex restricted trust game. They find that when subtle difference in instructions (describing subjects as "partners" rather than "opponents") are used to cue cooperative intentions, subjects are more likely to trust and reciprocate trust. Since our counterparts are simulated players, the relationship between facial characteristics and reciprocity cannot be examined: that is a topic for further study. None of the previous studies examines facial expressions, nor compares face-to-face with anonymous pairings in a common design.

There is considerable evidence that face-to-face interaction leads to different results from anonymous interaction in bargaining games. For example, Frohlich and Oppenheimer (1998) show that face-to-face communication in comparison to e-mail contact improved the joint prisoner's dilemma outcome of subjects. Roth (1995, 295–304) notes that face-to-face interaction is more likely to lead to efficient outcomes and equal distributions. In a time when more and more interactions take place via telephones and electronic mail, it is important to understand the role of nonverbal communication in face-to-face interactions. Video-conferencing and video-telephones might allow sufficient facial communication resulting in similar cooperative outcomes as face-to-face interactions. Further research is required in this direction as well.

In addition to the role of facial expressions, our results indicate that both male and female subjects are more trusting of members of the opposite sex. Our analysis provides some evidence that both women and men respond differently to male than to female facial expressions. Consistent with numerous findings from social psychology, these findings might be explained by subjects having a sexual interest in their counterparts. For example, Tidd and Lochard (1978) show that men gave larger tips than women to a smiling waitress, whereas there was no difference in tips when the waitress was not smiling. The simplest explanation might be that men earn more than women, but Tidd and Lochard also suggest that men might be motivated to give larger tips as a way of signaling interest to a women who is issuing a friendly (smiling) expression.

We also find that male subjects discriminate more between smiling and non-smiling counterparts whereas female subjects cooperate at similar levels

regardless of facial expression. An explanation of this result might be an effect of dominance. Individuals in subordinate roles smile more than individuals in power positions, regardless of their gender, as shown by Deutsch (1990) in simulated interview situations. Since men are more commonly in dominant positions, they might be more receptive to smiles than females. Therefore men might discriminate more between smiling and non-smiling faces. It may also be that women, who are known to smile more than men (Hinsz & Tomhave, 1991), do not regard smiling as an important, or honest, signal, because it has been overused.

Our research suggests that actors draw meaning from facial expressions. They use that meaning to condition their own behavior. The change in their own behavior may be due to the effect of facial expressions on beliefs about the counterpart, which are then used to formulate behavioral strategies. Inviting facial expressions may lead subjects to be more likely to forego a safe, best response (Nash equilibrium) strategy in favor of a risky, cooperative (trusting) behavioral strategy.

Thus, smiling is used by humans who are interacting in a one-shot game with strangers. This scenario is self-consistent, and would be evolutionarily stable if the signal were more costly to produce in the absence of the appropriate emotion. But as we discussed above, this assertion leaves the reason for the emotional reliability of smiling obscure. One likely explanation relates to the conditions in which human social behavior evolved. Humans are universally social and tended to live in small groups, and hence one-shot interactions may have been a rarity in their evolutionary history. Group living subjects interact repetitively, and reputations count because a fake smiler will be eventually recognized through her record, and hence discriminated against. When reputation for truthful expression of emotion is important, one might expect the evolution of psychological mechanisms that enforce it. If this interpretation is true, the evolved mechanisms will still be present in modern social conditions, when we sometimes interact with waiters once or play a one-shot trust game in the computer with a perfect stranger. Smiling to strangers may be a relic of our tribal past.

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