# FACE EVALUATION: PERCEPTUAL AND NEUROPHYSIOLOGICAL RESPONSES TO PRO-SOCIAL ATTRIBUTIONS

**Milena Dzhelyova**

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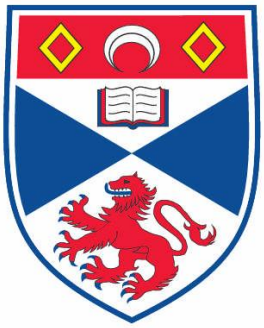
# Face evaluation: perceptual and neurophysiological responses to pro-social attributions

Milena Dzhelyova



This thesis is submitted in partial fulfilment for the degree of PhD
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# Note to the reader

Throughout the experimental chapters in this thesis, I have used the pronoun ‘we’ instead of ‘I’. This work is my own in terms of hypotheses, analyses and conclusions, however, the Perception Lab is an inherently collaborative environment with other members frequently assisting in the running of participants and the development of software. Such collaborative effort must be acknowledged. The plural pronoun reflects the fact that, if published, the following experiments would carry multiple authorship and is used in keeping with intellectual honesty.

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## Abstract

The pro-sociality of humans is manifested by the existence of cooperation in levels not common with any other species. Previous studies suggest that snap judgements of individuals are enough to determine if someone is a potential partner for cooperation. In addition to the often studied facial characteristics affecting cooperativeness and trustworthiness attribution (kin resemblance; attractiveness and emotional expression), the experimental work reported here examined the influence of head posture; gaze direction and skin colour on the attribution of trustworthiness and cooperation. A slightly tilted head (less than 3° downward) increased the perception of cooperativeness, especially for male and hostile looking faces. The importance of head tilt increased with decreased self-assessed dominance. Furthermore, even though some evidence that the effect of head posture is independent of gaze direction was found, gaze direction was also a strong indicator of cooperative intentions. Direct gaze and gaze slightly looking down (3°) were perceived as more cooperative than deviations of gaze outside this range (3° up or 6°- 9° down). Skin colour, a putative cue to current health status, was also found to impact on trustworthiness perception with a healthy skin colour increasing trustworthiness ratings. Additionally, as cooperative and trust decisions are vital for survival and social interactions, decisions based on facial appearance are made quickly and automatically as demonstrated by a trustworthiness modulation on an early face related component with 170 ms of exposure. Collectively, these findings suggest that facial characteristics employed to infer trust and cooperativeness help the observer to assess the motives and intentions of the individuals and assist the choice of partners that will lead to increased benefits

and reduced costs in collaborative actions. Such considerations fit well with the evolutionary theory of cooperation as reciprocated social exchange.

# Chapter 1

*Introduction to pro-social behaviour. Theories of evolution of cooperation*

Humans demonstrate more complex pro-social behaviour than other mammals. Pro-social behaviour here is used to describe acts in which an individual compromises his/her own wellbeing, encounters a cost, in order to increase the welfare of another individual (i.e. benefit another individual). Examples of pro-social behaviour can be drawn from the evolutionary history (i.e. hunter-gatherer's decision to cooperate in joint parental care, territory and group defence, political coalitions, trade etc.) or in many aspects of an individual's life: elections; online purchases or any other forms of informal help such as advice, exchange of benefits, restaurant tips. Furthermore, it has even been applied to states (e.g. the formation of the European Union in 1970 to protect European countries from future war: territory and group defence; and recently creating a major market for all members: trade). This flexible pro-sociality is intriguing and needs to be further investigated. This thesis focuses on two aspects of pro-social behaviour – trust and cooperation - and in particular what facial information is used in attributing these two pro-social characteristics. Social trust and cooperation are important factors for the proper functioning of the society. People routinely decide whether to trust and whom to trust in social situations, thereby exposing themselves to the risk of loss for the possibility of greater reward. Examples of such instances are a broad range of social interactions (e.g. interpersonal - trusting a confidant; economic - trusting an investment; and etc.). As 'cooperation' can be performed in different "currencies" (food for protection; money for goods/services and etc), these acts are also referred to as 'social exchange' (Cosmides & Tooby, 1992). These terms will be used interchangeably in the thesis.

Throughout the thesis, I will argue that facial characteristics, used to perceive individuals as cooperative and trustworthy partners, guide choices that maximise the

benefits or reduce the costs of the cooperative acts. I will emphasise the importance of head tilt, a nonverbal cue to display dominance, in perceiving cooperativeness. I will further explore the impact of health cues on perceived trustworthiness and examine the rapidness of the trustworthiness perception. First, three of the major evolutionary theories about cooperation will be outlined (see figure 1.1).

**Theories for the evolution of cooperation**

It is important to note that, in evolutionary psychology, in order for cooperation to evolve, possessing psychology driving pro-social behavour needs to improve the fitness of the individual (passing the individual's genes to future generations). One of the most widely accepted theories of evolution of cooperation is ***kin selection*** (Hamilton, 1964a, 1964b). An individual is more willing to help a closely related individual than a distantly related individual and less so to help an unrelated individual. By providing help, the individual decreases its direct fitness (i.e. reproductive success) thus incurs a cost (c) while the receiver of the help can benefit (b). Although, the direct fitness of the helper is decreased by assisting related individuals, the helper's inclusive fitness (the chance of reproducing helper's genes in further generations) is increased. Closely related individuals share more biological similarity (the amount of shared genes is higher, so the probability of having the same gene is higher). Therefore, close kin is more likely to receive help. For example, the genetic relatedness with a sibling is ½ while the genetic relatedness with a cousin is $\frac{1}{8}$ and so on, suggesting that the sibling is most likely to be helped as its close genetic relatedness is expected to exceed the cost benefit ratio of the altruistic act ($r > c/b$). Following from this argument, kin selection theory also predicts an increase

competition against individuals who are most distinctive from oneself (Hamilton, 1964a).

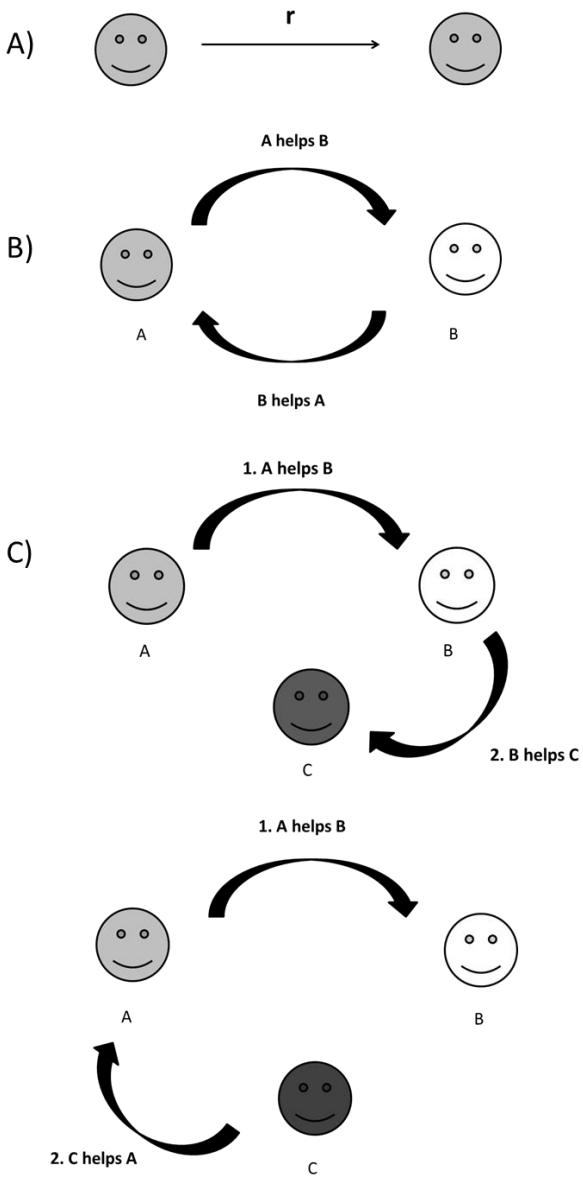


Figure 1-1. Theories for evolution of cooperation: A) **kin selection**: individuals cooperate due to genetic relatedness (r); B) **direct reciprocation**: cooperative acts are returned between the same two individuals at a later stage; C) **indirect reciprocation**: first row: cooperative acts are established as a result of a positive experience (a receiver of help might be motivated to help others); second row: cooperative acts are established as a result of reputation (a helpful individual is more likely to receive help or admiration). **Costly signalling** is related to reputation building in indirect reciprocation.

Human beings, however, do not cooperate only with related individuals. In fact, in most social groups, members other than family relatives are involved. Furthermore, cooperation can be observed not only among unrelated individuals but also among members of different species (symbiosis) (Trivers, 1971). Thus, a different mechanism is required to explain the evolution of human cooperation. One candidate theory is r***eciprocation*** (Trivers, 1971). Two forms of reciprocation are believed to promote cooperation – ***direct*** and ***indirect*** (e.g. (Nowak, 2006; Nowak & Sigmund, 1998; Trivers, 1971).

***Direct reciprocation*** is the exchange of cooperative acts between two individuals. It assumes that individuals will interact more than once, thus performing a costly act to benefit another individual will be returned by a reciprocated cooperation at a later stage. In other words, an individual responds to actions perceived to be kind in a kind manner. Such reciprocation of pro-social behaviour is observed in species that have long life span, live in small mutually dependent groups and are characterised with low dispersal rates. There is evidence that humanoid species have met these preconditions for evolution of reciprocal cooperation (for review see Trivers, 1971). Nevertheless, it is naïve to think that human cooperation has evolved only due to the belief that a pro-social act will be returned at a later stage as there are occasions when the receiver of the cooperation is not able to reciprocate or is able to perform subtle cheating in reciprocation (i.e. attempting to provide less than what one has obtained) (Trivers, 1971).

As an alternative explanation of evolution of pro-social behaviour, an ***indirect reciprocation*** mechanism is suggested (e.g. Nowak & Sigmund, 1998). In these cases, the individual offering help is relying on building a reputation which will be rewarded

by others. Providing benefits to the group increases the prestige of the individual and hence increases his/her mating opportunities. Two mechanisms can work in order to stimulate cooperation through indirect reciprocation (Nowak & Sigmund, 2005). If an individual helps another individual, the receiver, as a result of the positive interaction, can be motivated to cooperate with a third individual (Figure 1-1C first row) (Nowak & Roch, 2007). Although, this kind of reciprocity cannot allow for evolution of cooperation on its own, if it is linked to mechanism of cooperation such as direct reciprocation or network reciprocity (i.e group of individuals), it will greatly enhance the level of cooperation in a population (Nowak & Roch, 2007). Alternatively, the helper can also receive help from a different individual who was not involved in the social exchange (Figure 1-1C, second row) but observed or knew about the pro-social act.

Related to indirect reciprocation is the explanation of cooperation as ***costly signalling*** (e.g. Gintis, Smith, & Bowles, 2001; Zahavi, 1995). The cooperative act can be interpreted as an honest signal of mate quality and intentions. It is assumed that the cost of cooperation for a high quality individual is lower than the cost of cooperation for a low quality individual (Gintis, et al., 2001). Consider for example, participating in a group defence situation, which provides benefits for the group, and yet, the cost for the cooperative individual (the signaller) is smaller if the signaller possesses physical strength and dominance. By helping and cooperating, many of the helpers increase their own chances to breed. Often such costly acts are performed in front of many people rather than in front of single individual. Therefore, Zahavi (1995) argued that by investing in the welfare of another individual or the group, the helpers are advertising their quality and motives, thereby gaining 'social prestige'.

The social prestige functions as the peacock tail [1] – it attracts collaborators and deters rivals (Gintis, et al., 2001; Zahavi, 1995). During cooperation as a costly signalling, individuals can compete with each other to invest in the interest of the group and often can interfere with others helping. Following the costly signalling theory, before entering into cooperation, humans assess the motives and qualities of the possible collaborators, advertise their own motives and qualities and then decide who to choose for a partner.

It is clear that in order to reap the benefits of cooperation, cognitive and psychological adaptations need to have evolved. Some examples of those mechanisms are the development of language that conveys the information or the "gossip" about the previous behaviour and hence reputation of the society members; increased memory that keeps track not only of the personal encounters but also of the interactions between other members of the group; a 'cheater detection' mechanism that assists computing situations when violations of the social exchange can occur (i.e. one has been cheated, Cosmides & Tooby, 1992).

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[1] The quality of the peacock tail - its size, colour, luminosity, and symmetry - serves as an honest signal of the quality of the peacock's genes to potential mates. A high-quality tail is costly to have. It takes much metabolic energy and resources to grow and maintain such an ornament, which is not useful and even can be detrimental for survival (it can be easily seen by predators). Therefore, only peacocks in good health (can acquire abundant supplies of food) and those who can survive, are able to develop such high-quality tails. As a result the tail is an honest signal of their good genes.

Other examples of psychological adaptations, which may emerge through natural selection, are the overgeneralization of attributes (i.e. babyfaced features; emotion) and a negative bias in attributing trustworthiness and cooperativeness (Van Vugt, & Van Lange, 2006). An individual whose facial features resemble a baby face configuration will be a preferred cooperative partner than an individual whose facial features are more mature. The characteristic associated with a baby – naivety; physical weakness, warmth, submissiveness – and the appropriate responses to a baby – caring; protecting; inhibiting aggression – are mirrored in impressions about baby-faced individuals (Zebrowitz & Montepare, 2006). Similarly, an individual whose facial features resemble a positive emotional expression (smile) will be also a preferred cooperative partner than an individual whose facial features resemble angry expression. The importance to ascribe the correct behavioural response (approach a smiling person and avoid an angry individual) to individuals expressing these emotions, shapes a preparedness to overgeneralise this behaviour to individuals whose features only resemble the emotional expression.

To explain the negative bias in attribution of cooperative intent, let us consider the costs that an individual encounters if wrong decisions are taken during cooperation. Trusting someone who is believed to be a co-operator but in fact is not going to reciprocate is more detrimental than not trusting someone who is believed to be a non-cooperator, but in reality is a trustworthy individual. Due to this asymmetry in cost, a strong negative bias can evolve. A typical example of a negative bias is the adaptation of females to underestimate the male's commitment to invest in paternal care (Haselton & Buss, 2000, 2009). Another example of a negative bias is the

avoidance of individuals who are physically more robust as cooperative partners, as they can potentially exploit with impunity (Stirrat & Perrett, 2010).

As outlined, it is difficult to sustain cooperation without discrimination between recipients. This is the place where the notion of trust can be introduced. Trust and trustworthiness perception can be an adaptation to protect the individual from engaging in interactions with poor exchange partners or individuals who are not willing to reciprocate (Trivers, 1971; van Vugt & van Lange, 2006). A model of trustworthiness perception (Oosterhof & Todorov, 2008) suggests that this trait attribution is an extension of the ability to read emotional expression. Thus, it is derived from the resemblance to emotional expression and is attempting to infer behavioural intentions in order to guide approach-avoidance behaviour (Todorov, 2008). Exaggerating emotionally neutral faces along the trustworthiness continuum creates expressive faces: untrustworthy looking faces are perceived as angry while trustworthy looking faces - as happy. As a result trustworthy looking individuals can be approached and chosen as potential partners while untrustworthy looking counterparts are avoided as they can potentially inflict harm on the individual. Given the importance of trustworthiness judgements for social interactions and survival, it is not surprising that individuals attribute trustworthiness automatically (e.g. Todorov, Loehr, Oosterhof, 2010 but see Santos and Young, 2005 for weak evidence of spontaneous encoding of trustworthiness using an isolation effect [2]).

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[2] isolation effect – events (stimuli) that are incongruent and rare (in numeric minority) with their prevailing context are better remembered than the surrounding items and a proper control item. The paradigm was introduced by von Restorff (1933).

Converging evidence for automatic processing of trustworthiness are provided from the neuroscience literature (e.g. Winston, Strange, O'Doherty, & Dolan, 2002). In particular, the amygdala – a structure involved in social processing (Adolphs, 2010) – is responsible for the implicit (automatic) processing of trustworthiness while superior temporal sulcus – a structure involved in processing of the changeble aspects of the face (e.g. emotional expression; gaze direction; movements (Haxby, Hoffman, & Gobbini, 2000) - is recruited during explicit judgements of trustworthiness (Mattavellli, Andrews, Asghar, Towler, & Young, 2012; Winston, Strange, Doherty, & Dolan, 2002; for a detailed discussion of the brain regions involved in and further evidence for spontaneous processing of trustworthiness perception see chapter 6). In fact, a transcranial magnetic stimulation study suggested a critical involvement of right superior temporal sulcus in explicit judgements of trustworthiness (Dzhelyova, Ellison, & Atkinson, 2011).

In many situations individuals are encountered for the first time and there is no information about reputation. On such occasions, trustworthiness perception can be based on facial appearance. Structural and emotional cues are the main sources of information for forming trustworthiness impressions (Oosterhof & Todorov, 2008). The structural cues can relate to shape difference between female and male faces or age (maturity), while the expressive cues resemble changes in the facial features conveying emotional expression (for a detailed description of facial aspects influencing trustworthiness attribution see chapter 2). Santos and Young (2011) reported that trustworthiness attributions, based on the whole face or images only of the internal facial features, are performed equally efficiently. Furthermore, the eye and the mouth region of a face contribute more to the trustworthiness perception than

the upper face region (forehead). Besides face shape and configural cues impacting on trustworthiness perception, recent literature acknowledges the importance of texture and skin tone information for forming this trait attribution (Santos & Young, 2008; Todorov & Oosterhof, 2011, see also chapter 6).

## Empirical investigation of trust

Most of the studies investigating trustworthiness perception have employed a rating task or a two alternative force choice (trustworthy vs untrustworthy). A different experimental approach to investigate cooperation and trustworthiness is the economic games. The economic games are often used as an operational measure of trust and cooperation. Four commonly employed games will be introduced in the following section.

### Economic games

#### Public goods game

In the public goods game, a group of individuals (N) receives an endowment and each player can independently decide whether he/she wants to contribute any amount of the endowment to a common pool. The rest of the money is kept by the participant. The decisions are done simultaneously and anonymously. The amount of money contributed to the pool is multiplied by a factor **a** (**a** is smaller than N). In some modifications of the game, the pool has to exceed a certain amount (threshold) before it is multiplied by the factor. This restriction imposes a minimal donation amount. The resulting sum is distributed equally among all members regardless of

their initial contribution. Because as a benefit to any invested amount, the individual receives $^{a}/_{N}$, a maximizing outcome strategy is not to invest in the common pool.

Prisoner's Dilemma

The name of the game derives from anecdotal story about two prisoners who have jointly committed a crime and have been apprehended. The District Attorney cannot prove their guilt and can only convict them if one or both confess their crime. He is questioning the prisoners individually without any opportunity for them to communicate with each other. Each prisoner is given a deal:

1) If you confess and the other prisoner does not – you will go free while the other prisoner will receive the maximal sentence.
2) If both of you confess – both of you will receive moderate sentences.
3) If none of you confesses – both of you will get the minimal sentence.

In each case, the dominant strategy is to confess as the individual will perform better: if the accomplice confesses as well the prisoner will get the moderate rather than the maximal sentence while if the accomplice does not confess the prisoner will go free rather than have a moderate sentence. However, the dilemma results from the fact that duel confession leads to a moderate sentence while no confession leads to a minimal sentence.

In economic terms, the two individuals can each choose whether they want to cooperate or to defect (not cooperate) and each is awarded a sum of money dependent on their interaction. None of them knows the choice of the other counterpart. There are several possible outcomes: (a) both players cooperate - mutual cooperation - the

sum of money is divided equally by the two players; (b) only one of the players cooperates while the other one defects - unilateral cooperation (unilateral defection) - the cooperater gains nothing while the non-cooperater gains the whole sum of money; and the last possible outcome is when (c) both players do not cooperate - mutual defection – than both will gain a small sum of money, which is smaller than the one that can be gained by mutual cooperation (see Figure 1-2). Regardless of the partner's choice, the best option in Prisoner's Dilemma game is to defect since it yields higher payoff. Yet, if both partners defect, both do worse than if they both had cooperated.

| | | **Player B** | |
|---|---|---|---|
| | | cooperate | do not cooperate |
| Player A | cooperate | **2**, **2** | **0**, **5** |
| | do not cooperate | **5**, **0** | **1**, **1** |

Figure1-2. Example payoff matrix for the Prisoner's Dilemma. The payoff matrix for follows the rule: unilateral defection (not cooperate; cooperate) > mutual cooperation (cooperate; cooperate) > mutual defection (not cooperate; not cooperate) > unilateral cooperation (cooperate; not cooperate).

The game could be played sequentially or simultaneously and as multiple or one-shot interactions with the same partner. The optimal strategy within an iterated game was Tit for Tat (Axelrod & Hamilton, 1981). This is a simple strategy which starts with cooperation and then, the player does what the partner did in the previous move. Thus, the strategy honours cooperation and punishes defection. As a result, cooperation is established by reciprocation. The problem is that once a defection has occurred – even by mistake – the players are locked in series of defective acts (vendettas) until one of them cooperates (Nowak & Sigmund, 1993). An alternative model suggested that win – stay, lose – shift strategy, in which a player repeats the

previous choice if it was successful but switches if it was not beneficial, outperforms Tit for Tat (Nowak & Sigmund, 1993). The reasons for the better performance are that the strategy 1) protects against exploitation; 2) corrects mistakes and 3) exploits a naïve co-operator (Nowak & Sigmund, 1993; Nowak, 2006; Trivers, 2005).

Trust Game

The Trust Game is a two stage game, also played by two individuals. One of the players has the role of the trustee (recipient) and the other is the investor. Initially, both players are given an endowment. In some variations of the game, only the investor receives the endowment. The investor decides if he/she wants to give some money to the trustee. If money is invested than it is increased (doubled or tripled) by the experimenter, and the trustee receives the resulting sum. At the second stage, the trustee has the option either to return a portion of the money to the investor or to keep the whole sum. Rationally, the investor should not trust the recipient and not invest initially, while the recipient should keep all of the received money. Thus, the game can be employed as an operational measure of **trust** by investigating the decisions of the investor and an operational measure of **trustworthiness** by exploring the decisions of the trustee.

Ultimatum Game

In a standard Ultimatum Game, a sum of money is given to one of two players, the proposer. The proposer has to decide how he/she would like to split the money between himself/herself and the other player. After receiving an offer from the proposer, the other participant, the responder, has the opportunity either to accept the money or to reject it. An acceptance of the offer leads to a gain for both players: the

responder receives the offered money, while the proposer keeps the rest of it. Conversely, a rejection leads to a loss for both of the participants since none of them receives any money. Rationally, as players interact just once, the proposer should always offer the smallest amount of money and the respondent should always accept the offer since even a small monetary gain is better than nothing.

The classical theory of economic decision-making assumes that decisions are made rationally - trying to maximise gain and minimise lost. Therefore, choosing to defect in Prisoner's Dilemma; accepting every amount of money offered in Ultimatum Game; not returning any profit in Trust Game or not contributing to the common pool in a Public Goods Game should be the rational choice of every player. However, research on this topic demonstrates results inconsistent with the rational expectations. For example, participants cooperate almost 50 % of the occasions in Prisoner's Dilemma. Clark and Sefton (2001) reported 42% of cooperation if participants had to play as a first mover in a sequential Prisoner's Dilemma game. Similarly, in Ultimatum Game, the proposer tends to offer 50% of the amount of money in order for the offer to be accepted. Proposals of less or equal to 20 % of the amount of money seem to be considered as unfair and the other participant is often motivated to punish the proposer by rejecting the offer (for an overview see Sanfey, 2007). In the early rounds of public goods games also most of the partners donate to the common pool with contributions ranging from 40% to 60 % of the endowment (Fehr & Schmidt, 1999). A meta-analysis of approximately 162 studies investigating economic behaviour in the Trust Game suggested that on average the investors trust around 50% of the initial endowment while the trustees return approximately 37% of

the resulting money (Jonson & Mislin, 2011). These results suggest that factors other than pure monetary gain play a role in social interactions.

Decisions to cooperate are biased by affection, empathy and mood (Wischniewski, Windmann, Juckel, & Brüne, 2009). Furthermore, in instances where reputation can be built, cooperation is increased (Bateson, Nettle, & Roberts, 2006; Haley & Fessler, 2005). Thus for example, communicating with (Kurzban, 2001) or seeing (Witchman, 1970) a partner influences positively cooperation rates. People contribute (Bateson, et al., 2006) and cooperate (e.g. Haley & Fessler, 2005; Rigdon, Ishii, Watabe, & Kitayama, 2009) more if they were exposed to eyes looking at them. These situations can be perceived as being seen by other and thus, as opportunities to build or lose reputation (Bateson, et al., 2006; Haley & Fessler see also Fehr & Schneider, 2010), providing experimental evidence for reputation-based mechanisms for evolution of cooperation, one of the varieties of indirect reciprocation (Nowak, 2006; Nowak & Sigmund, 1998).

Additional studies have investigated how partner's personal traits and explicit social information about one's partner can influence the economic decision-making. For example, van't Wout and Sanfey (2008) suggested that the perceived trustworthiness of a partner is a strong social cue that influences decision-making. Information about partners' moral status, acquired through the previous decisions in the game (Singer, Kiebel, Winston, Dolan, & Frith, 2004) or provided explicitly by information given prior to the game (Delgado, Frank, & Phelps, 2005) effects social interactions within the course of the game. Reputation, measured as the investor's reciprocity, in a sequential Trust Game in which the same pairs of partners were playing for several rounds, predicts the change of trust by the trustee (King-Casas et

al., 2005). Even facial characteristics have been suggested to influence pro-social attributions and social exchange (Hancock & DeBruine, 2003). Chapter 2 will outline some of them.

# Chapter 2

*Faces and pro-social attributions*

People's behaviour can be perceived and inferred from properties such as appearance, voice, movement etc. Evolutionary theory predicts that these inferences are based on mechanisms that have evolved in order to solve evolutionary problems – thus 'perceiving is for doing' (Zebrowitz & Montepare, 2006). The perception of others serves an adaptive function to increase survival and goal achievement. This chapter will focus on the information about individuals inferred from facial appearance.

Typically, there is a high degree of consensus about judgements inferred from faces. People agree on perceptions of objective characteristics such as age (e.g Burt & Perrett, 1995; Tranel, Damasio, & Damasio, 1988; Winston, Strange, Doherty, & Dolan, 2002) and gender (e.g. Brown & Perrett, 1993; Burton, Bruce, & Dench, 1993; Roberts & Bruce, 1988) as well as on characteristics thought to be based on individual preferences or culturally determined such as attractiveness (e.g Langois et al., 2000, Perrett et al., 1998). Indeed, individuals perceived as attractive in one culture are also perceived as attractive by other cultures (e.g. Langois et al., 2000; Perrett et al., 1998). Judgements of other personality traits such as trustworthiness (Cronbach's $\alpha = .93$) [3]; sociality ($\alpha = .92$); aggressiveness ($\alpha = .92$); intelligence ($\alpha = .90$); responsibility ($\alpha = .91$); dominance ($\alpha = .93$) (Oosterhof & Todorov, 2008) produce high agreement, although these judgements are not independent. Similar results are reported by other experiments.

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[3] Cronbach's alpha, α, is a measure of reliability. It ranges from 0 to 1 and values greater than > .7 - .8 indicate acceptable or good internal consistency of the measure. It should be noted that the value of α depends on the number of items and with increasing number of items high level of αcan be obtained (Field, 2005).

In a study (Jones, DeBruine, Little, Watkins, & Feinberg, 2011) investigating the impact of context manipulation on perception of dominance and trustworthiness, the authors reported a high inter-rater agreement for these judgements (all $\alpha > .82$). Carré et al. (2009) demonstrate that people agree at attributing aggressiveness ($\alpha = .95$). Consensus in personality judgments done at 'zero acquaintance' (i.e. inferred from facial appearance) could result from shared stereotypes about particular physical appearance characteristics (Albright, Kenny, & Malloy, 1988).

The validity of personality judgements based on facial information has been questioned (e.g. Alley, 1988; Cook, 1939). Following the argument that the perceptions of trait have evolved as adaptive mechanisms solving an evolutionary problem, it should be expected that there is a 'kernel of truth' in attributing traits based on facial appearance. Indeed, people can judge health more accurately than expected by chance (e.g. Kalick, Zebrowitz, Langlois, & Johnson, 1998; Coetzee; Perrett & Stephen, 2009), dominance (e.g. Berry, 1991), and even aggressiveness (Carré, McCormick, & Mondloch, 2009) based solely on facial appearance. Self-reported extraversion and openness match judgements of facial images made by independent judges (Penton-Voak, Pound, Little, & Perrett, 2006). Female facial composites created by averaging individuals who rated themselves high or low on conscientiousness, extroversion, agreeableness and neuroticism were accurately judged for these personality traits by raters, although, male composite faces were judged correctly only for extroversion (Little & Perrett, 2007). Leadership judgments made from faces of unfamiliar political candidates have predicted real election outcomes from across the world (for a review see Olivola & Todorov, 2010). Even

face judgments of leadership ability made by children predict electoral success, and match similar decisions made by adults (Antonakis & Dalgas, 2009).

Collectively, these findings suggest that there is some validity of impressions based on facial appearance – the "kernel of truth" hypothesis (Bond, Berry, & Omar, 1994). It is worth noting that the correlations between facial appearance and personality traits range from approximately $r$ = .23 for judgements of extroversion, (Penton-Voak et al., 2006) to $r$ = .42 for judgements of aggressiveness (Carré, et al., 2009) and $r$ = .47 for judgements of dominance (Berry, 1991), suggesting that the importance of these predictions based on facial appearance will be different. Thus, facial appearance will explain between 6% and 22% of the variability in these personality traits. Yet, even small characteristics can impact on people's decisions and therefore, influence future interactions. It is also important to note that most of these studies are done with Western participants and cross-cultural research suggests that there are differences between Western and Asian participants in forming trait attribution (e.g. Walker, Jiang, Vetter, & Sczesny, 2011).

The accurate detection of behavioural opportunities: cooperating, harming, trusting, should have even greater functional value in terms of goal achievement and survival than attributions of personality traits (e.g. agreeableness; extroversion etc.) and therefore it should be expected that attributions about traits conveying those intentions to be more accurate (Montepare & Zebrovitz, 2006). In the rest of this chapter the facial characteristics used for inferring behavioural traits such as cooperativeness and trustworthiness will be summarised. A remark on the validity of these cues will also be provided.

**Face resemblance**

As mentioned earlier, favoring the kin in cooperative situations (Hamilton, 1964a) is one of the main predictions of kin selection theory as a driver for the evolution of cooperation. Cues to kinship can be direct or indirect (Hauber & Scherman, 2001). Spatial location and familiarity (although, correlated with actual kinship during evolutionary history, these cues might not be very reliable indicators of relatedness nowadays) are regarded as indirect cues while phenotypic indicator of relatedness – odour, vocal or facial resemblance – are examples of direct cues to kinship.

When subtle cues of face resemblance are presented, cooperation for public goods is facilitated. In a group based economic game, the amount of contribution made by a participants was increased as the number of self-resembling group members increased (Krupp, Debruine, & Barclay, 2008). Similar findings are reported for trustworthiness perception. Stimuli of same (DeBruine, 2002) and opposite sex faces (DeBruine, 2005), that are subtly manipulated to resemble the participants' own faces are judged to be more trustworthy than if the same faces are judged by control subjects. Interestingly, the higher trustworthiness ratings for the opposite sex images were not a result of higher attractiveness ratings. Self-resemblance in opposite sex faces generally has a negative effect on their attractiveness ratings (DeBruine, Jones, Little, & Perrett, 2008). In fact, women with younger brothers were less attracted to self-resembling, unfamiliar male faces than were women with older or without brothers (DeBruine et al., 2011) suggesting that mechanisms for kin recognition are guided by evolutionary specific mechanism – cooperation and inbreeding-avoidance behaviour.

Further evidence for a developed cognitive mechanism dealing with kin recognition in the context of cooperation comes from a study investigating the perception of individuals with antiself-resemblance in different contexts: short and long term relationship as well as trustworthiness (Krupp, DeBruine, Jones & Lalumiere, 2012). Faces manipulated to look less like the participants' own faces (antiself-resemblance) were judged less positively than faces with self-resemblance irrespectively of the context, supporting Hamilton's view that rivalry or competition will be addressed predominantly toward individuals that are most distinct from oneself.

**Attractiveness**

Attractiveness is a facial characteristic influencing cooperativeness and trustworthiness attribution. Generally, good-looking people are judged to possess positive characteristics – being more sociable, intelligent and competent (for reviews see Dion, Berscheid, & Walster, 1972; Langlois et al., 2000, but see also Eagly, Makhijani, Ashmore, & Longo, 1991). Thus, it is not surprising that this 'halo effect' is also elevating cooperative and trustworthiness perception. Attractive individuals are expected to be more cooperative in Prisoner's Dilemma games (Mulford, Orbell, Shatto, & Stockard, 1998) and more generous when making offers in Ultimatum Game (Solnick & Schweitzer, 1999; Wilson & Eckel, 2006) but they are also offered more as a recipient in economic games and they are a preferred cooperative partner (Mulford et al., 1998).

Little evidence is available regarding the accuracy of cooperativeness and trustworthiness judgements based on attractive facial appearance. Although, attractive

individuals are perceived to be more cooperative and trustworthy, in fact, they are found to be less cooperative in economic games (Mulford, et al., 1998; Takahashi, Yamagishi, Tanida, Kiyonari, & Kanazawa, 2006). For example, Takahashi et al (2006) showed photographs of male defectors as measured by participants' responses in Prisoner's Dilemma and demonstrated that they were judged to be physically more attractive than male cooperators, while no such effect was found in females. The reason for that could be that beautiful males are desirable partners. As a result they have more social exchange opportunities and thus can afford not to reciprocate.

**Sexual dimorphism**

Sexual dimorphism impacts on pro-social attributions. To put the influence of sexual dimorphism on pro-social attributions into context, the effect of it on attractiveness will be briefly outlined. Evolutionary theory suggests that sex typical features increase attractiveness perception. Secondary sexual features become exaggerated during puberty under the influence of steroid hormones. Testosterone is believed to enhance the growth of facial hair, chin, brow bridge, check bone etc. while oestrogen inhibits the expression of these features (for an overview see (Thornhill & Moeller, 1997). Furthermore, higher levels of estrogen increase perceived femininity and health (Law Smith et al., 2006). Importantly, testosterone is also thought to inhibit the immune system. Therefore, being able to develop secondary sexual traits is possible only for high quality mates (i.e Folstad & Karter, 1992; Hamilton & Zuk, 1982; Zahavi, 1975). Consistent with this hypothesis are findings suggesting that facial masculinity is linked to better medical history (Rhodes, Chan, Zebrowitz, & Simmons, 2003) and shorter durations of past illnesses (Thornhill & Gangestad, 2006). Consequently, sexually dimorphic traits should be judged as

more attractive and preferred in mate choice. Preferences for 'super-female' in female faces are well established (e.g. Little, Jones, DeBruine, & Feinberg, 2008; Perrett et al., 1998; Rhodes, Hickford, & Jeffery, 2000). However, mate choice preferences for facial masculinity in male faces are controversial with some studies finding preferences for masculine faces or males with high testosterone levels (e.g. DeBruine et al., 2006; DeBruine, Jones, Smith, & Little, 2010; Rantala et al., 2012) while others reporting preferences for feminine looking male faces (e.g. Little & Hancock, 2002; Perrett, et al., 1998; Rhodes, et al., 2000) or no preferences (Scott & Penton-Voak, 2011). Some of the differences in the results can be explained by situational: relationship context (e.g. Little, Jones, Penton-Voak, Burt, & Perrett, 2002); own conditions of the judges: attractiveness and femininity (Little, Burt, Penton-Voak, & Perrett, 2001; Penton-Voak et al., 2003), menstrual cycle (e.g. Johnston, Hagel, Franklin, Fink, & Grammer, 2001; Little, Jones, & DeBruine, 2008; Penton-Voak et al., 1999); and environmental aspects (e.g. DeBruine, Jones, Crawford, Welling, & Little, 2010; Little, DeBruine, & Jones, 2011), all of which affect masculinity preferences.

The clear link between attractiveness and femininity in women suggests that feminine female faces will be perceived as more trustworthy. It is more difficult to hypotheses the effect of masculinity in men on trustworthiness due to the equivocal results regarding the preferences for masculinity in attractiveness studies (e.g. Debruine et al 2006; Perrett et al., 1998; Rhodes et al., 2003). If masculinity is used as a putative cue to long term health, one would expect that masculine partners will be preferred. Engaging with healthy partners will be more beneficial for an individual not only because a contamination can be avoided but also because a healthy partner is

likely to acquire more resources (for a detailed discussion of benefits associated with trusting and cooperating with healthy partners see chapter 6). However, masculine features are associated also with perception of increased dominance (e.g. Mazur & Booth, 1998; Watkins, Jones, & DeBruine, 2010), a quality that might be avoided in partners as they can exploit with impunity. Experimental findings clearly suggest that feminine male and female faces are perceived as more trustworthy. In a variety of social contexts, masculine faces are perceived as less honest, uncooperative (Perrett et al., 1998) and untrustworthy (Buckingham et al., 2006; Oosterhof & Todorov, 2008).

This tendency is also reflected in a general bias regarding female individuals as more trustworthy and cooperative while male individuals as more untrustworthy and exploitative. Anecdotal evidence suggest that women are more trustworthy are available cross-culturally. For example, in Mexico City, due to the belief that female officers are less likely to take bribes, all-female teams of traffic officers were created (Treaster, 1999 as cited in Buchan, Croson, & Solnick, 2008). Experimental evidence also indicates that women are less likely both to take bribes and to condone taking bribes and that countries with greater female participation in public life demonstrate lower levels of corruption (Dollar, Fisman, & Gatti, 2001; Swamy, Knack, Lee, & Azfar, 2001). Furthermore, women's facial anatomy is more neotenous (babyfaced), characterised with big eyes and forehead; and small chin and nose, than men's. Individuals with this 'cute' or childlike look are perceived more naïve, honest and warmer (McArthur & Berry, 1987; Zebrowitz & Montepare, 2005), traits that will enhance trustworthiness attributions.

This stereotypical bias is also present in the effort to ascribe trustworthiness to female and male faces. When judging faces varying in trustworthiness, participants

are faster and more likely to attribute trustworthiness to female than male faces (Dzhelyova et al., 2011, see also chapter 5). They also give higher ratings of trustworthiness to female faces than male faces (Mehu, Little, & Dunbar, 2008), suggesting that these two dimensions are not completely independent.

Results from economic game studies suggested that women are more trustworthy as they reciprocate initial investments more often, although in Trust Games, men trust initially more and thus they can be viewed as more cooperative as they initiate a cooperative exchange (Buchan, et al., 2008). However, it is worth pointing out that men are also involved more in heroic and chivalrous cooperation (Eagly & Crowley, 1986) and are more cooperative when there is an out-group competition than women (van Vugt, Cremer, & Janssen, 2007).

Sexually dimorphic features

Other facial parts that are important for making judgments about the person's trustworthiness are the brow ridge, the cheekbones, the chin; the nose (Todorov, Baron, & Oosterhof, 2008) and the eyes (Schul, Mayo, & Burnstein, 2004). Faces with higher inner eyebrow line, pronounced cheekbones and wide chins were judged to be more trustworthy than faces with lower inner eyebrow line, shallow cheekbones and thin chin (see Figure 2-1 A). Additionally, faces with rounder eyes are perceived as more trustworthy than faces with narrower eyes (Schul, et al., 2004). As mentioned in the previous subsection, the development of these features is related to the hormonal levels. For example, female faces have more protuberant checks and conversely, male faces have more pronounced chin and brow ridge (Enlow & Hans, 1996; Moss, Linney, Grindrod, Arridge, & Clifton, 1987 see Figure2-1B). These

features – nose, eyes, brow ridge, chin – are also used to discriminate female from male faces (e.g. Brown & Perrett, 1993; Roberts & Bruce, 1988).

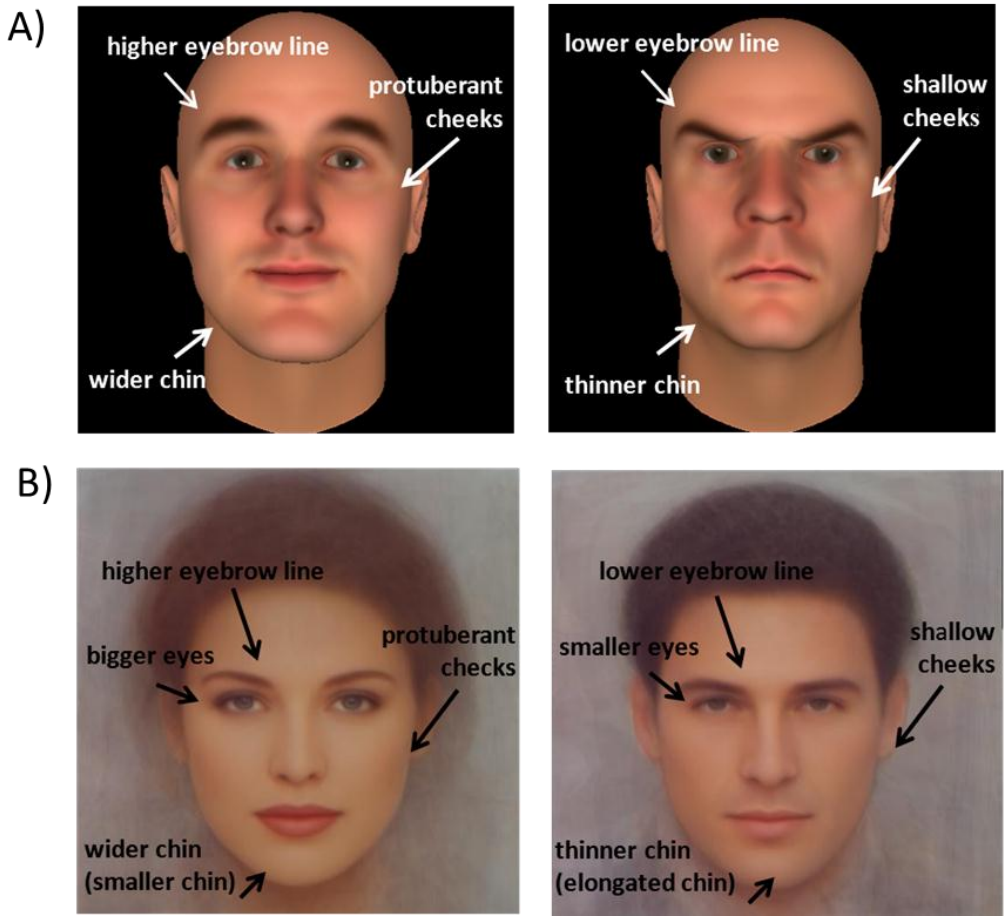


Figure 2-1. Facial features contributing to trustworthiness attribution and sex discrimination. A) Differences in facial features contributing to trustworthiness attribution: trustworthy and untrustworthy face (examples of images adapted from Oosterhof & Todorov, 2008). The faces are based on a model of trait attributions characterised by two dimensions (trustworthiness and dominance). The first dimension explained 63.3 % while the second – 18.3% of the variance in the data. B) Differences in facial features between female and male faces

Facial Width to Height Ratio

The facial width to height ratio, a putatively sexually dimorphic feature (Weston, Friday, & Liò, 2007), is measured in skulls as the ratio of the bizygomatic width to the distance from the nasion to prosthion (upper facial height). In facial

photographs, the distance between the eyelids and the upper lip is used as an approximation of the upper facial height (see Figure 2-2). Male and female individuals were reported to differ in the ratio as males have wider faces than females while both genders have relatively similar upper facial height, resulting in a greater ratio in men (Weston et al., 2007). A recent study (Lefevre et al., 2012) re-examining the notion of sexual dimorphism associated with this ratio revealed that in four different samples (adults aged approximately 83 years; Caucasian and African students photographed with 2D camera; and Caucasian students photographed with 3D camera) there was no difference between males and females. Nevertheless, this ratio is linked to behaviours more stereotypical for male individuals: dominance and aggressive behaviour as counted by the penalties in hockey players (Carré & McCormick, 2008); achievement drive in politicians (Lewis, Lefevre, & Bates, 2012) cheating and deception (Haselhuhn & Wong, 2012) and success of CEOs (Wong, Ormiston, & Haselhuhn, 2011).

The facial width to height ratio also influences the perception of trustworthiness (Stirrat & Perrett, 2010). Men with wider faces are perceived as less trustworthy, particularly if the evaluators are subordinate female individuals. An explanation, proposed by the authors, is that such individuals are more vulnerable to exploitation and as a result they pay more attention to subtle characteristics conveying untrustworthiness. There is a kernel of truth in this perception as males with higher width to height ratio behave more exploitatively and do not reciprocate initial investments in Trust games (Stirrat & Perrett, 2010). Surprisingly, males with higher width to height ratio are more self-sacrificing towards the in-group in competitive situations with an out-group (Stirrat & Perrett, 2012). Such heroic acts might be

interpreted as evidences supporting theories of cooperation through reputation building (Nowak & Sigmund, 1998) or through costly signaling acts (Gintis et al., 2001; Zahavi, 1975).

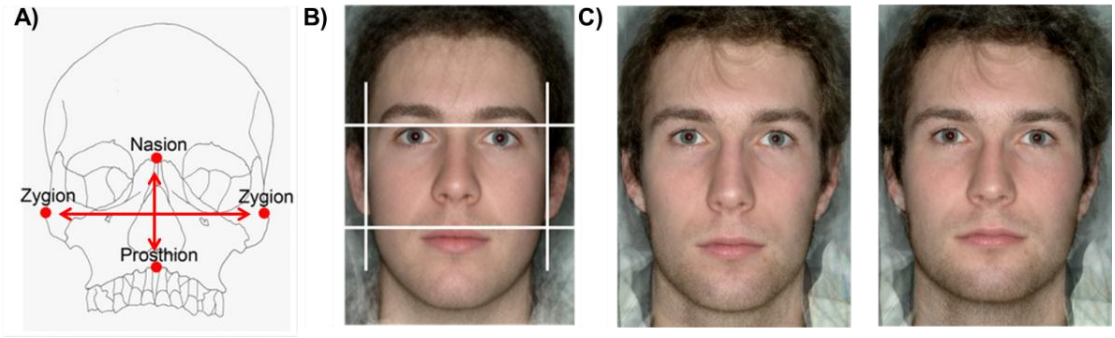


Figure 2-2. Width to height ratio. A) Measurement on the skull: facial width – bizygomatic distance; upper facial height – distance from the nasion to the prosthion. B). Estimation of the metric (horizontal lines represent upper face height – measured as the distance between the upper lip and the highest point of the eyelid; vertical lines represent face width – measured as the distance between the outer points of the cheeks) C). Manipulation of the same image to decrease (left) or increase (right) the width to height ratio, affecting judgements of trustworthiness: more trustworthy (left); less trustworthy (right)

Symmetry

A widely used indicator of phenotypic quality is the degree of symmetry (fluctuating asymmetry). Fluctuating asymmetry is estimated as the individual variation between left and right bilateral characters (i.e. legs; hands, arms, ears etc.) that tend to be symmetrical at population level (e.g. Valen, 1962). It is suggested to be a marker of developmental stability (optimality) (genomic properties that allow an organism to compensate for environmental challenges and developmental changes) which in turn can be an indicator of pathogen resistance and the "quality of the genes" (Gangestad, Thornhill, & Yeo, 1994). Symmetry, therefore, can be a proxy of mating quality. Natural variations in body and face asymmetry affect attractiveness – more asymmetrical faces and bodies are perceived as less attractive (e.g. Gangestad, et al.,

1994; Grammer & Thornhill, 1994). Converging evidence is provided from experiments systematically manipulating face shape symmetry suggesting that increasing facial symmetry increases attractiveness ratings (Perrett et al, 1999).

Research investigating associations of cooperative behaviour and individuals fluctuating asymmetry in faces reported that participants were more cooperative towards symmetrical individuals (low fluctuating asymmetry). Further investigation revealed that when the incentive for cooperation is "attractiveness", participants are more cooperative with symmetrical individuals while they are more cooperative towards asymmetric individuals if the motivation is perceived "need" in the partner (Zaatari, Palestis, & Trivers, 2009).

The accuracy of the favorable perception of high symmetry males is questioned by results suggesting that fluctuating asymmetry is positively related to the amount of money offered in ultimatum game. Indeed, 25% of the variance in the behaviuor (the offers given by male individuals) can be explained by the asymmetry of their faces (Zaatari & Trivers, 2007). Conversely, individuals with high fluctuating asymmetry are more cooperative in Prisoner's Dilemma games (Sanchez-Pages & Turiegano, 2010) and offer fair offers in the Ultimatum Game (Zaatari & Trivers, 2007).

Emotional expression

Another aspect influencing cooperation and trust is apparent emotion. Emotional expressivity can elicit trust and thus cooperation (Boone & Buck, 2003; Schug, Matsumoto, Horita, Yamagishi, & Bonnet, 2010). In particular, smile - a signal of positive attitude – similarly to attractiveness has a 'halo effect' on attributions of

personality traits (e.g. Lau, 1982; Mehu, et al., 2008; Otta, Lira, Delevati, Cesar, & Pires, 1994). It also impacts positively on impressions of generosity (Mehu, Little, & Dunbar, 2007; Mehu, et al., 2008) and altruism (Brown & Moore, 2002). Furthermore, a smile in male but not in female face images increases the choice to cooperate in Prisoner's Dilemma as compared to faces with neutral expression (Eckel & Wilson, 2003). Yet, both smiling female and male stimuli were judged to be more friendly and cooperative than the neutral versions. In addition to static smiles, the duration of a dynamic smile impacts trustworthiness perception. Longer duration of a smile, therefore perceived as more authentic, increases trustworthiness ratings (Krumhuber, Manstead, & Kappas, 2007).

While smile and positive expressions increase trust, anger and negative expression decrease trust (Oosterhof & Todorov, 2008). For example, exaggeration of the features conveying trustworthiness in computer-generated neutral faces produced faces with emotional expression. The untrustworthy faces were judged to express anger and were characterised by V-shaped brows and □-shaped mouth while the more trustworthy faces were judged to express happiness and were characterised by the opposite pattern **Λ**-shaped brows and U-shaped mouth (Oosterhof & Todorov, 2008, see Figure 2-3).

Emotional expression, however, can also be posed and easily faked (Ekman & Friesen, 1982; Ekman, Friesen, & O'Sullivan, 1988) and thus may not convey the truthful nature of person's intentions. People perform above chance level at discriminating authentic Duchene smiles from posed smiles (Frank, Ekman, & Friesen, 1993) and are able to use this skill to discriminate genuine cooperators from

defectors. For example, if participants are asked to interact in economic games with individuals expressing authentic and posed smiles they prefer to cooperate with those ones expressing a truthful smile (Krumhuber et al., 2007; Scharlemann, Eckel, Kacelnik, & Wilson, 2001).

Additionally, if participants are presented with pictures taken during the choice to cooperate or defect on their counterparts, the respondents are able to distinguish defectors from cooperators (Verplaetse, Vanneste, & Braeckman, 2007; Yamagishi, Tanida, Mashima, Shimoma, & Kanazawa, 2003) or altruist from not-altruist as measured by self-reported altruism by comparing video clips of natural conversations (Oda, Naganawa, Yamauchi, Yamagata, & Matsumoto-Oda, 2009). This discrimination might be based on cues from negative emotional expression (Okubo, Kobayashi, & Ishikawa, 2012).

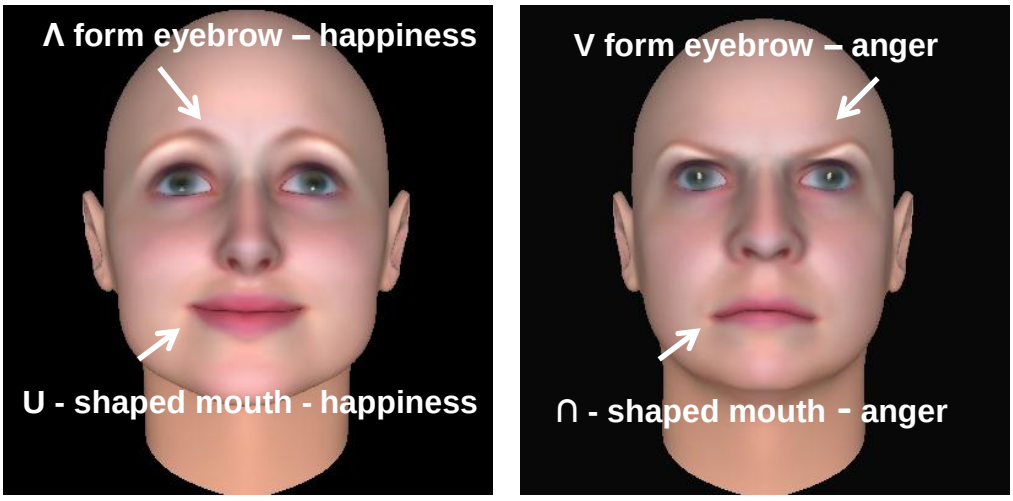


Figure 2-3. Resemblance between emotion expression and trustworthiness (images adapted from Oosterhof & Todorov, 2008). Trustworthy face resembles a smiling face while untrustworthy face is perceived as more angry.

From the outlined literature, it becomes clear that facial aspects strongly influence the decision who to cooperate with and trust. People are preferentially

trusting individuals whose facial features suggest reduced cost (feminine; smiling individuals) or increased benefit (symmetrical; attractive; related individuals). In the next experimental chapters facial characteristics cueing dominance (reduced cost) or health perception (increased benefit) will be investigated. In chapter 3, an appearance aspect – a subtle head tilt, approximately 3 ° downwards – will be introduced as a cue of cooperativeness. Chapter 4 will evaluate individual differences in sensitivity to head tilt. Head tilt was associated with eye movement in chapter 3. The eyes are known to be an indicator of social intent (Calder et al., 2002), therefore chapter 5 will compare the effect of head posture and gaze direction. The last two chapters will be related to trustworthiness perception. Chapter 6 will examine how cues to health influence trust and mate choice while the last experimental chapter will explore the automaticity of trustworthiness attributions by employing a neurophysiological approach. In the concluding chapter the findings will be summarised and some future directions will be suggested.

# Section 1: Cooperation

## Chapter 3

*Head tilt and facial appearance effects on cooperativeness*

## Abstract

Subtle facial cues influence the perception of cooperation. Given that posture affects status, emotion and attractiveness attribution, head tilt might enhance some attributes relevant to deciding whether to cooperate with someone. This study investigated if the perception of cooperativeness is linked to head posture. In two interactive experiments we asked students to rotate 3D facial images along the vertical plane so that they looked most cooperative. The results revealed that participants tilted the faces slightly down independently of the visibility of the eyes, suggesting that the postural effects on cooperation are primarily due to head position rather than gaze direction. Additionally, the downward head tilt was increased if the faces were perceived as unfriendly. Taken together, the findings from these experiments suggested that head posture is a cue influencing cooperativeness.



Keywords: head posture; cooperation; facial appearance

## Introduction

Cooperation is common between individuals even if they are not related (Axelrod & Hamilton, 1986; Trivers, 1971). On occasions a snap decision is made as to whether someone is cooperative or not even if only limited information is available. In many situations, decisions are based solely on facial appearance. For example, attractive people are regarded as more cooperative than less attractive individuals (Mulford, et al., 1998) and facial resemblance to individuals facilitates cooperation for public goods (DeBruine et al., 2009; Krupp, et al., 2008). Another example of a heuristic cue influencing cooperativeness perception is emotional expression. People use emotion in order to discriminate genuine from manipulative cooperators. If participants are asked to interact in economic games with individuals expressing authentic and posed smiles they prefer to cooperate with those expressing a truthful smile than with individuals with a posed smile (Krumbhuber et al., 2007; Scharlemann, et al., 2001; Wilson & Eckel, 2006).

Facial appearance can be altered just by variations of the head tilt (e.g Burke & Sulikowski, 2010; Mignault & Chaudhuri, 2003). Posture could also influence trait attributions because of associations biased by experience. For example, during situations when one individual is on a platform, viewers normally see the individual from below (with a tilted up head) which increases the perception of dominance and height, characteristics influencing social judgements such as leadership (e.g. Re et al. submitted, Rule & Ambady, 2008). To this end, we set out to investigate if head posture will affect appearance of cooperativeness.

The perception of different characteristics, affecting cooperativeness attribution, can be influenced by subtle changes in head tilt. For example, attractiveness of female faces is increased if they are tilted downward (Burke & Sulikowski, 2010). This downward tilt increases femininity perception in female faces and decreases masculinity perception in male faces. Additionally, head posture impacts perceived emotional expression. Lyons et al. (2000) found that faces tilted down appear happier - bowing the head down creates the illusion of the mouth corners being curved up, leading to the impression that a face is smiling. Contradictory findings have been also reported - tilting the head up can also make the face appear happier (Kappas Hess, Barr, & Kleck, 1994; Mignault & Chaudhuri, 2003).

Head posture also influences dominance perception. Mignault and Chaudhuri (2003) demonstrated that faces tilted up are perceived as more dominant while faces tilted down are perceived as more submissive (cf. Kappas, et al., 1994). Additional research associates dominance with pride and points to a common nonverbal expression – expanded posture with head tilted up (Shariff & Tracy, 2009). Given that feeling proud is often a consequence of success, the nonverbal expression of pride might function as a demonstration of achievement and thus boost status. It is worth mentioning that a meta-analysis revealed that the expectation that dominance displays are expressed by expanded posture or head up is stronger than their actual demonstration in natural situations (Hall, Coats, & Smith LeBeau, 2005).

The present study

Since vertical head orientation is a nonverbal cue affecting emotional expression, dominance and attractiveness, all of which influence perception of cooperativeness, we set out to investigate the optimal head tilt signalling maximal cooperativeness. We hypothesised that head posture will affect appearance of cooperativeness. Concerns for reciprocation will affect the choice of a cooperative partner, therefore we hypothesised that head tilt increasing femininity and positive emotion as well as reducing masculinity and dominance perception will impact positively on cooperativeness perception. From the outlined literature, it was expected that downward rotation will increase cooperativeness attribution. Two interactive experiments in which the apparent posture of 3D heads could be altered by changing the viewing angle (see Figure 3-1) were devised.

Manipulating the posture of the 3D models also changes the gaze direction. As gaze direction is a powerful social cue used as a signal of person's intentions (e.g. Calder et al., 2002) and gaze shifts modulate person perception: whereby direct gaze increases the perception of positive emotional expression, dominance and attractiveness (e.g. Adams & Kleck, 2003, 2005; Main, Jones, DeBruine, & Little, 2009; Mason, Tatkow, & Macrae, 2005), in the second experiment, we investigated if head posture has an effect on cooperativeness perception independent of gaze direction by obscuring the eyes of our stimuli. The participants' task was to adjust the head tilt to maximise the cooperative appearance of individual faces. The utilization of 3D images enabled us to examine the cue from a new perspective. Previous experiments examining the importance of head posture had used mainly 2D images.

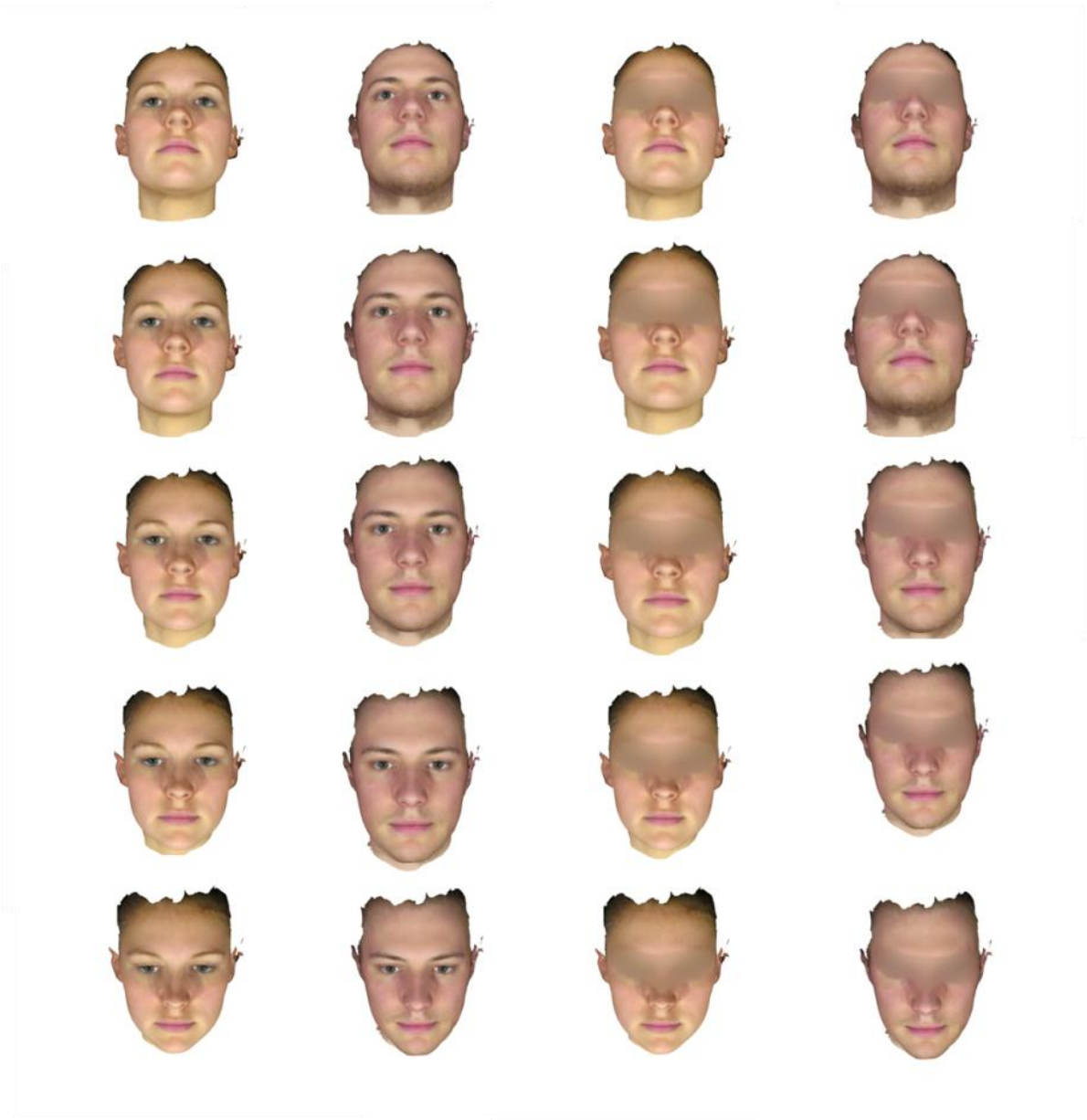

Figure 3-1. Rotation (up: 20°, 10°, level: 0°, down 10°, 20°) for a female and a male head model in Experiment 1 (columns 1 and 2) and experiment 2 (columns 3 and 4). Note: Light source is constant positioned in front of the models. The head is rotating relative to the light source.

2D images might induce biases. For example, male individuals might pose with heads slightly up, a nonverbal display to enhance dominance perception which will be captured in the 2D images. Furthermore, the 3D models give a better representation of the facial structure, which in comparison to 2D shape is not influenced by the distance or the lenses used during image capture, thus 3D photography provides a more realistic impression of the facial appearance.

Additionally, the experiments aimed to address whether any postural cues to cooperativeness are affected by other facial cues to emotional expression and dominance. Models of trait attribution suggest that perception of individuals can be described by two dimension – warmth/emotional valence and competence/dominance (e.g. Fiske, Cuddy, & Glick, 2007; Oosterhof &Todorov, 2008; Wiggins, 1979), and as outlined in chapter 2, either of these two dimensions impact on cooperativeness perception. Consequently, the posture maximising cooperativeness may depend on the facial expression and dominance of the facial images. A happier person is perceived as more agreeable and approachable, thus should be a preferable partner for cooperation. A person who is more submissive is less likely to exploit; hence may be perceived as more cooperative.

## Experiment 1

### Methods

#### Participants

Forty-four (21 male) students, age range 18 - 36 ($M$ = 20.95, $SD$ = 3.56), participated in the experiment. The study was approved by the University Teaching

and Research Ethics Committee at the University of St Andrews (Approval code: PS5970). All of the respondents provided signed and informed consent. Data from 2 participants were excluded due to incomplete data sets resulting in 42 participants.

## Materials

### Experimental images creation

Thirty male and 90 female 3D photographs of Caucasian students ($M$ = 20.72, $SD$ = 1.73) were selected to generate head models used as experimental stimuli. The limited number of male images was based on the available males in the dataset. Photographs were taken using a 3dMD camera (for technical details, see http://www.3dmd.com/3dmdface.html). It is a non-invasive imaging technique, providing 180° coverage of the head (ear to ear). No hair information is provided. Clothing was not visible and the individuals had posed with a neutral expression. 3D photographs give shape and texture information (see Figure 3-2), thus both of them can be individually manipulated. Similarly to 2D images, the shape of 3D images is delineated using 38 unique points. In order to be able to manipulate the images, an additional step, different from 2D image manipulation, is necessary. Each face needs to be registered to a standard face as the number of vertices defining the shape of the image is different. This additional step equates them and automatically crops the images under the neck area (see also Re et al., 2011). Thus, it allows the shape information to be manipulated (i.e. averaging or transforming images).

Figure 3-2. 3D photographs; shape – depth map (left) and texture (right) information.

After this initial processing, thirty female and 29 male 3D head models were produced by averaging data from trios of individual faces (see also Coetzee, Re, Perrett, Tiddeman, & Xiao, 2011). The averaging process was employed to create realistic looking faces that were not recognizable as any one person; they would therefore appear unfamiliar to the participants. 3D model generation was done in an equivalent manner to that used for 2D face image processing (see Rowland & Perrett, 1995; Tiddeman, Burt, & Perrett, 2001). Images were not masked; therefore shape information of the head contour was available. Morphanalyser (Tiddeman, Rabey & Duffy, 1999) was used to produce 61 JPEG images of each of the 3D head models at 1° intervals of rotation on the vertical plane ranging from 30° down to 30° up. The image sequence was then converted into AVI movie files running at 15 frames per second using Fast Movie Processor v1.44.

Stimuli calibration

To have an approximation of 0° of head rotation, another 15 (six male) students, age range 18 - 29 ($M$ = 20.07, $SD$ = 3.08), took part in a calibration study as a course requirement (Ethical approval code: PS6035). Their task was to manipulate the 59 head models so that the faces were looking directly at them. The average angle judged as direct gaze was used as an equivalent of 0° head rotation in further calculations. High agreement on the angle judged as direct gaze for each image (Cronbach's $\alpha$ = .97, N = 59) was demonstrated.

Emotional expression of the stimuli

To estimate subtle differences in emotional expression and dominance perception of the faces and thus address if they impact the final angle of rotation, another 31 (15 male) students, age range 18 - 30 ($M$ = 20.06, $SD$ = 2.71), rated on a 7-point Likert scale the heads on perceived submissiveness (1 – not at all submissive; 7– very submissive) and emotional expression (anger: 1 – not at all angry; 7 – very angry) and happiness (1 – not at all happy; 7 – very happy). Participants took part in the experiment as a course requirement. Participants' agreement was high on the scales: submissiveness (Cronbach's $\alpha$ = .88, $M$ = 3.62, $SD$ = 0.49, N = 59); anger ($\alpha$ = .97, $M$ = 3.03, $SD$ = 0.84, N = 59) and happiness ($\alpha$ = .95, $M$ = 3.71, $SD$ = 0.82, N = 59). Thus, consensus ratings (averaged across participants) from the head evaluation tasks were used. Because the ratings were correlated (happy and submissive, $r$ (59) = .42, $p$ = .001; happy and angry, $r$ (59) = -.89, $p$ < .001; submissive and angry; $r$ (59) = -.63, $p$ > .001), a principal component analysis was performed on them. Using Kaiser's criteria, PCA revealed one component accounting for 77 % of the variance in

the data. Submissive and happy ratings were loading positively on the component (.75 and .90, respectively) while angry ratings were loading negatively (-.97), thus the component will be referred to as friendly (unthreatening) appearance (see Figure 3-3).

Figure 3-3. Visualisation of the component 'friendly appearance': left image: high scores - friendly appearance; right image: low scores –unfriendly appearance. Note: images are composite head models created by averaging the top 10 images (5 males).

Procedure

The participants were asked to rotate each of the faces in the vertical dimension by moving the mouse cursor until the face looked most cooperative. Presentation order of the stimuli was randomised. Each head had a different starting tilt to minimise any systematic biases.

## Results

### Effect of head posture on cooperative appearance

To investigate whether posture has an effect on the attribution of cooperativeness, the tilt chosen was calculated as the difference between the final angle of rotation for each of the 59 faces and the mean angle for that face estimated as direct gaze (the calibration study). For each of the 42 participants, the average rotation was calculated across the 59 heads. This angle was compared against a hypothesised mean difference of 0° of rotation (indicating no consistent head tilt or direct gaze). Negative rotation values indicated that the heads were rotated downwards while positive values indicated upward rotation.

To maximise the cooperative appearance, head models were significantly rotated downwards ($M$ = -2.48°, $SEM$ = 0.70; $t(41)$= -3.53, $p$ =.001, $r$ = .48 (see Figure 3-4 for comparison). Therefore, the result suggested that head posture influences the appearance of cooperativeness and a slight downward tilt of the head looked most cooperative.

Figure 3-4. Example of a composite image directly looking at participants (left, calibration study) and most cooperative looking (right, rotated down by 3°).

Effect of friendly appearance

To evaluate any variations in the head angle optimizing cooperativeness attribution based on counterparts' facial characteristics, an ANCOVA with the mean angle for each stimulus maximizing cooperativeness as a dependent variable; the sex of the face as a fixed factor and the 'friendly appearance' (the PCA score for that image) as a covariate was run. To test whether the influence of 'friendly appearance' was equivalent across the sexes, an interaction term sex of face by 'friendly appearance' was added to the model. Partial eta² and Pearson's correlation coefficients are reported as effect sizes.

There was a main effect of sex of face, $F(1, 55) = 4.63$, $p = .036$, $\eta_p^2 = .08$, $r = .28$, indicating that the male faces ($M = -3.04$, $SEM = .42$) as compared to female faces ($M = -1.25$, $SEM = .41$) were rotated down further in order to look most

cooperative. There was an effect of the covariate 'friendly appearance', $F(1, 55) = 5.46$, $p = .022$, $\eta_p^2 = .09$, $r = .30$ (see Figure 3-5), suggesting that faces were rotated down less if they were perceived as friendly and non-threatening. There was a trend for interaction between sex of face and friendly experience, $F(1, 55) = 3.08$, $p = .085$, $\eta_p = .053$, $r = .23$ .

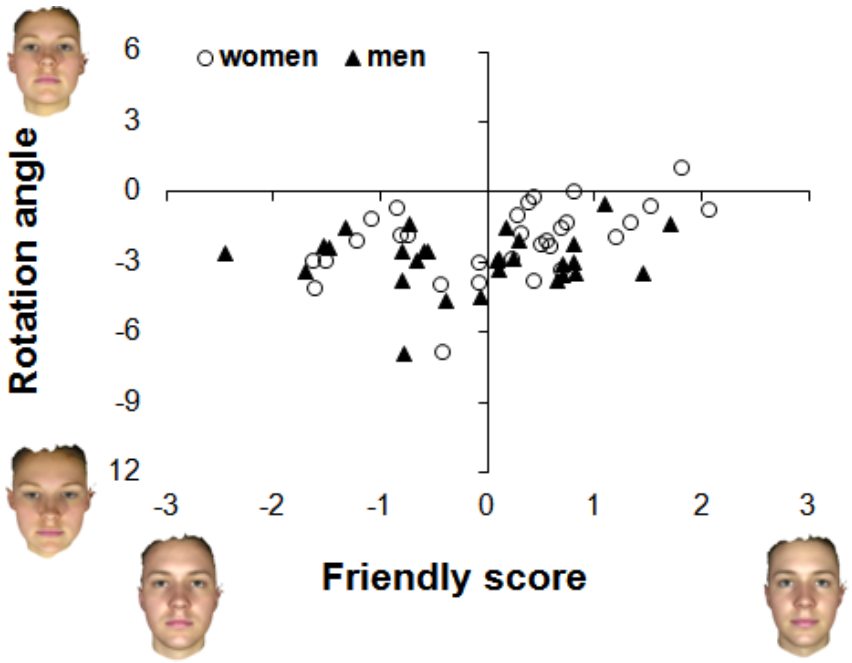


Figure 3-5. Rotation angle based on the sex and perceived appearance of the face with visible eyes (experiment 1).

## Experiment 2

The second experiment aimed to investigate the effects of head posture on the perception of cooperativeness independently of gaze. It was expected that if the preferred downward rotation in experiment 1 was due to postural cues, a similar rotation angle for maximizing cooperativeness should be observed.

### Method

Participants

Thirty nine (18 male) students, age range 18 – 28 ($M$ = 20.54, $SD$ = 2.54) were recruited. All participants provided signed and informed consent.

Materials

The same materials as in experiment 1 were used. However, the eyes and the eyebrow region were blurred on the texture maps of the 3D head models using Photoshop software (see Figure 3-1).

Procedure

The same procedure as in experiment 1 was applied. In addition, a chin rest was used to guarantee that the viewing angle for all participants was equivalent. Although, differences in the procedure makes the comparison between the two experiments more difficult, similar results will increase the validity of the findings.

## Results

Effect of head posture on cooperative appearance

The angle of rotation maximizing cooperativeness perception for every participant was calculated in the same way as in experiment 1. Participants rotated the faces in the second experiment downwards ($M$ = -1.98, $SEM$ =.72). The resulting angle of rotation significantly differed from 0° of rotation ($t$(38) = -2.76, $p$ = .009, $r$ = .-41) as revealed by a one sample t-test. Therefore, posture rather than gaze direction affected the perception of cooperativeness. In sum, these findings suggest that gaze

direction cannot be the reason for tilting the heads down since the eyes were obscured**.**

Effect of friendly appearance

An ANCOVA was run with the mean angle for each stimulus with obscured eyes maximizing cooperativeness as a dependent variable; sex of face and the covariate 'friendly appearance' and the interaction term between sex of face and 'friendly appearance'. There was a main effect of sex of face**,** $F(1, 55) = 9.37$, $p = .003$, $\eta_p^2 = .15$, $r = .38$**,** confirming that male faces were rotated further down to look cooperative ($M = -3.04$, $SEM = .42$) than female faces ($M = -1.25$, $SEM = .41$) and the effect of the covariate 'friendly appearance' was also significant, $F(1, 55) = 20.43$, $p < .0001$, $\eta_p^2 = .27$, $r = .52$ (see Figure 3-6). Faces perceived as more friendly were rotated less downwards. These results reaffirmed the importance of facial characteristics when ascribing cooperativeness. The interaction between sex of face and 'friendly appearance' reached significance, $F(1, 55) = 12.76$, $p = .001$, $\eta_p^2 = .19$, $r = .43$, suggesting that irrespectively of the appearance, male faces were rotated down while female faces were rotated down only if they appeared unfriendly.

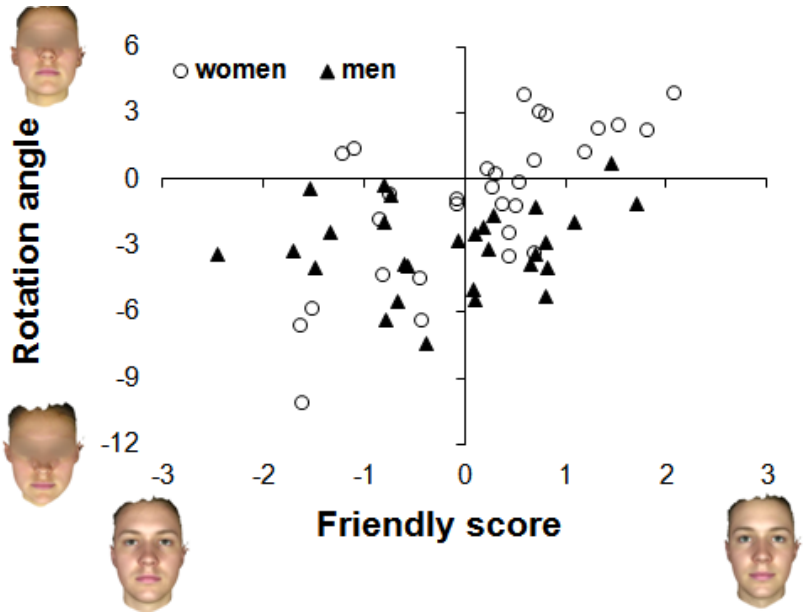


Figure 3-6. Rotation angle based on the sex and perceived appearance of the face with blurred eyes (experiment 2).

## General discussion

We investigated the effects of head posture on cooperativeness. It was hypothesised that head tilt influences apparent cooperativeness since head posture affects perceived attractiveness, emotional expression and dominance. In particular, downward head tilt was expected to increase cooperativeness attribution as it increases perception of feminine and positive emotional expression and decreases perception of masculinity and dominance. The results from the two experiments confirmed that a downwards tilt of the head is perceived as more cooperative. Furthermore, male and unfriendly looking female faces were rotated further down in order to appear most cooperative.

The impression that people look most cooperative when their head was tilted slightly down might be a result of an association with postural cues of status. The downward rotation to maximise cooperative appearance is consistent with head

posture symbolising submissiveness (Mignault & Chaudhuri, 2003) and increasing femininity perception (Burke & Sulikowski, 2010). It might be speculated that participants prefer a cooperative partner expressing a submissive attitude or a willingness to adopt a role that does not dominate the interaction. Furthermore, experiment 2 further elaborated on these findings and indicated that the effect of head posture on apparent cooperativeness is not a result of lowered gaze. For cooperation, a display of lowering the head may confirm that an individual is not a threat.

Seeking a low dominant individual as a partner for a cooperative venture will reduce the chance of exploitation since this cooperation partner will not be as able to implement hostile intentions. Such results are consistent with the interpretation that facial characteristics associated with dominance lower the perception of honesty and trustworthiness (Perrett et al., 1998; Smith et al., 2009; Stirrat & Perrett, 2010) and increase attributions of antisocial behaviour (Carré, McCormick, & Mondloch, 2009; Kruger, 2006).

Both experiments provide evidence that the facial characteristics impact attributions of cooperativeness. Overall, male faces and faces that were perceived as more threatening were rotated downwards more, thus further suggesting the validity of the interpretation that the downward rotation of a face reflects an association with signals of submissiveness and friendliness. Furthermore, the effect of the facial characteristics increased with obscuring the eyes. Many trait estimations may be a result of a valence evaluation assisting a quick assessment whether to approach or avoid an individual (Todorov, 2008). Thus, cooperativeness may also rely primarily on subtle facial cues signalling emotional expression. The effect of counterpart's facial characteristics (emotional expression, dominance) and gender on the head tilt

applied to maximise cooperativeness further supports the interpretation that bowing the head is an important display of cooperation and is associated with signalling subordinate behaviour. Alternatively, it is possible that tilting the head down makes the facial expression appear happier (Lyons et al., 2000), thus hostile looking faces need to be tilted further down in order to achieve the same level of friendliness and cooperativeness display.

Several limitations of the experiments need to be addressed. A definition of cooperativeness was not provided to the participants and thus the interpretation of the term may have differed between participants. Yet, people are adept in interpreting the term and solving the task without additional information. Another problem with the eye manipulation can be that blurring the eye region of a face creates artificial images that do not present natural stimuli and thus better controlled images can be issued in order to assess the influence of gaze direction of cooperativeness attributions. The use of 3D photographs enabled us to create realistic head models with more structural information; however, the use of these photographs introduces some artefacts such as nose shading or edges along the hair line that can be overcome in further experiments.

The main purpose of this study was to investigate if head posture affects cooperativeness appearance. We hope to provoke future research that takes into account postural differences when assessing trait attribution. Furthermore, future studies can address how different context or additional characteristics of the observer impact on this perception. For example, shorter or less dominant people might prefer the faces to be rotated further down. We have not controlled for participants' height in either of the experiments, however, the use of a chin rest in the second experiment suggest that the downward head tilt preferred for cooperation should not depend on

viewing angle. Furthermore, recent research suggests that facial cues to height are different from head posture (Re, et al., in press). Overall, the results indicated that subtle changes in the head tilt can have strong effects on attributions and may well affect cooperation in society.

# Chapter 4

*Individual differences in the importance of head tilt as a display of cooperativeness*

## Abstract

Previous results suggested that tilting the head a few degrees down is perceived as more cooperative than keeping the head level, potentially a consequence of an association with postural cues signalling submission. Since cooperation is bidirectional, we investigated how characteristics of the perceiver and the counterpart influence the importance of the head posture. The results suggested that the importance of the postural cue differs based on perceivers' dominance and the perceived hostility in the counterparts. Thus, subordinate individuals appear to require a greater display of willingness to cooperate expressed by a tilt of the head when the counterpart appears more threatening.



Keywords; head posture; facial appearance; cooperation; self-assessed dominance

## Introduction

In the previous chapter, the counterpart's characteristics were examined in order to assess how different facial aspects influence the rotation angle maximizing cooperativeness. Cooperation between individuals, however, is bidirectional and thus the perception of cooperativeness and decisions to cooperate with a counterpart also depend on the perceiver's characteristics. For example, the choice of whether to trust and to cooperate with someone can be influenced by self-perceived attractiveness and self-assessed dominance. Individuals that view themselves as highly attractive are more likely to cooperate with others perceived as attractive (Mulford, Orbell, Shatto, & Stockard, 1998). Female evaluators who rate themselves low in dominance judged male individuals with wider faces to be less trustworthy (Stirrat & Perrett, 2010). Such evaluators might be more vulnerable towards exploitative male individuals and pay more attention to signals conveying the males' potential ability to act on negative intentions.

Collectively, trait attributions made to faces are affected by the characteristics of the observer and the counterpart. Therefore, this chapter set out to re-analyse the data collected in experiment 1 and evaluate how both the counterparts' and perceivers' characteristics affect the head posture maximizing cooperativeness. Self–perception of dominance was of particular interest to us as the findings reported in chapter 3 suggested that in order to maximise cooperativeness perception, a slight bow of the head is required. Provided that the downward rotation is a result of an observer's desire the counterpart to display a wish not to dominate the interaction, we expected that the facial characteristics of the counterpart have a greater effect on subordinate individuals. These individuals might be more sensitive to facial aspects that convey

the counterparts' capacity or intention to exploit. To sum up, this chapter aims to re-evaluate the effects in perceivers' preferences for the optimal head position based on the perceivers' self-assessed dominance and the counterparts' facial characteristics.

## Method

### Participants

Participants' information is provided in chapter 2, experiment 1.

### Materials

#### Facial Stimuli

Images were the same as in experiment 1 described in chapter 3. To compare the results from this chapter with the results reported in chapter 3, grouping of the facial appearance ratings of the images was performed. A median split of the consensus ratings was applied to separate the images into groups – submissive/dominant (*Median* = 3.68), happier/less happy (*Median* = 3.77) and angrier/less angry (*Median* = 2.94). By dichotomising the variable, information is lost. Yet, it will make it possible to compare whether there are differences in rotation angle based on perceived facial appearance of the head models. Thus, using this procedure the results from the previous chapter performed on the ratings of the faces (i.e. continuous variable) can be replicated.

There was a gender bias in the dominance judgements (60% of the female images were classified as more submissive). No gender bias was observed in the ratings of the emotional expressions. The images rated as happier were also the

images rated as less angry (excluding four images that were ambiguous in scores and were classified as both less happy and less angry and one image rated as both happier and angrier). Thus, the 54 images uniquely considered as happier or angrier were used to group the stimuli based on emotional expression.

Dominance Assessment

A brief questionnaire assessing participants' self-rated dominance was administered after completing the experiment. Dominance can be measured by the physical robustness and the ability to impose one's will (physical dominance) or also by leadership and persuasion (social dominance) (Henrich & Gil-White, 2001). To measure physical and social dominance, Puts et al.'s (2006) items addressing these two characteristics were used. A full version of the questionnaire can be found in appendix A. To assess social dominance participants were presented with a definition of social dominance: "A **SOCIALLY DOMINANT person tells other people what to do, is respected, influential and often a leader; while submissive people are not influential or assertive and are usually directed by others!".** Participants indicated whether they perceive themselves as highly submissive or highly dominant on a 7-point scale (1– highly submissive; 7 – highly dominant). To assess physical dominance participants answered on a 7-point Likert scale how likely (1- not very likely; 7 very likely) it is that if they were engaged in a physical fight with a same-sex peer, they would probably win. Additionally, to have a better assessment of physical dominance a picture version of the Self-Assessment Manikin (SAM) scale measuring dominance (Bradley & Lang, 1994) was administrated. Participants were asked to match their physical robustness to a picture corresponding to their dominance. The

two measures of physical dominance were significantly correlated ($r$ = .56, $p$ < .001, N = 42).

Procedure

The procedure of the experiment is described in chapter 2. After completing the task, participants filled in the questionnaire assessing self-perceived dominance.

Analysis

Preliminary principle component analysis indicated that all three dominance measures positively loaded on one factor explaining 64.4 % of the variance in the ratings (loadings for SAM, physical dominance and social dominance were .80, .86, .74, respectively). Thus, to evaluate any differences in rotation angle based on participants' own dominance, a new power characteristic was devised combining participants' self-reported physical and social dominance. As a measure of physical dominance, the mean value ($M$ = 4.20, $SD$ = 1.23, *Median* = 4.25) of the two items assessing physical dominance (SAM rating and Puts et al's (2006) item measuring physical dominance) was used. Participants reporting a mean physical dominance smaller than or equal to 4 were regarded as physically less dominant. The cut-off value for the social dominance measure was set to 5, determined by a median split, since the majority of the participants reported a high level of social dominance ($M$ = 4.61, $SD$ = 1.06). Using these two measures the participants were separated into three groups. Twelve (five male) participants were considered to have low power as they judged both their physical and social dominance as low. Eleven (five male) participants were considered to have mid power. They judged either their physical or social dominance as low but the other measure of dominance as high. Nine of these

participants reported low physical dominance. The nineteen remaining participants (10 males) had scores indicating high physical and social dominance and were considered as having high power. To evaluate differences in the posture maximizing cooperativeness based on perceivers' characteristics we used the grouping of the participants in these three power groups. This helped us to avoid referring to the same participants when describing the effects of self-rated social or physical dominance on the head posture optimising cooperativeness.

To address any differences in the posture maximizing cooperativeness attribution based on counterparts' characteristics, we used the grouping of images based on their emotional expression because of the absence of gender bias in these ratings. Additionally, the submissiveness and emotional appearance ratings (anger and happiness) of the original images were correlated (see chapter 3). For each participant two final angles maximizing cooperation for happy looking and angry looking heads, respectively, were calculated.

To evaluate any variations in the head angle optimising cooperativeness attribution based on perceivers' dominance and counterparts' emotional expression, we ran a 2 x 3 mixed ANOVA with the mean angle for stimuli's emotional expression (happier, angrier) as a within-subject factor and participants' power (high, mid, low) as a between subject factor. Post hoc tests compared only high and low power groups. Any differences in optimal posture for cooperativeness based on counterparts' characteristics will be more clearly seen in a comparison between these individuals. Note that if the analysis was performed with the regression scores for the power characteristics of the factor analysis, results were replicated (see note 4).

## Results

The 2 (stimuli's emotional expression: angrier, happier) x 3 (participants' power: high, mid, low) mixed ANOVA revealed a main effect of stimuli's emotional expression stimulus emotion, $F(1, 39) = 9.91$, $p = .003$, $\eta_p^2 = .21$, $r = .45$, suggesting that angrier looking faces ($M$ = -3.27°, $SEM$ = .78) are rotated further down than happier looking faces ($M$ = -2.09°, $SEM$ = .74). No main effect of participants' power was revealed, $F(1, 39) = .18$, $p = .84$, indicating that the head tilt maximizing cooperativeness for the different power groups was similar. There was a significant interaction between emotional expression and participants' power, $F(2, 39) = 4.13$, $p = .024$, $\eta_p^2 = .17$, $r = .31$. The interaction reflected a lack of difference in the rotation degrees for happier and angrier looking faces for high power individuals ($t(18) = .28$, $p = .79$) while low power individuals rotated angrier looking faces significantly more than happier looking faces ($t(11) = -2.70$, $p = .021$, $r = .63$, see Figure 4-1).

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[4] Similarly to the ANOVA analysis, an ANCOVA with emotional expression (happy vs angry) as a within subject variable and a covariate - the regression scores of the PCA analysis - revealed a main effect of emotional expression, $F(1,40) = 6.67$, $p = .014$, $\eta_p^2 = .14$, suggesting that angry faces were rotated further down than happy faces. Importantly, there was an interaction between the emotional expression and the covariate, $F(1, 40) = 5.64$, $p = .022$, $\eta_p^2 = .12$, suggesting that decreasing participant's self-rated dominance (physical and social), increased the rotation angle for angry looking faces.

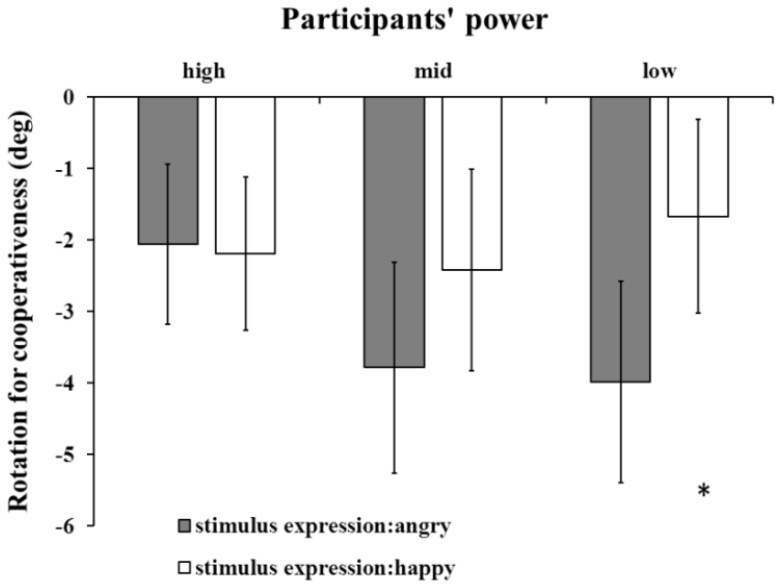


Figure 4-1. Power status of observers and counterparts' facial expression affect head tilt to maximise cooperative appearance. Heads with more angry expressions are tilted down further than heads with happy expressions particularly by observers with low power. (*Significantly different at $p < .025$).

## Discussion

It was hypothesised that posture influences of cooperativeness will be contingent on the observer's characteristics. The results indicated that the low dominant individuals were more sensitive to the valence of the expression of the partners' faces and rotated the heads with angry expression further down than the heads with happy expression. Increasing participant's dominance decreased the postural effects of head tilt on cooperation. Thus, overall the results further support the interpretation that to maximise cooperative appearance the downward rotation is an expression of a desire not to dominate the interaction.

Angrier faces were rotated further down to look more cooperative. Angry looking faces are judged to be more dominant and dominant individuals are perceived as expressing anger (e.g. Hess, Adams, & Kleck, 2005; Knutson, 1996; Montepare &

Dobish, 2003; Oosterhof & Todorov, 2008; Zebrowitz et al., 2010). The generalization between emotional expression and dominance was present in the ratings of the head models in the experiment. Increased perception of submissiveness increased the perceived happy expression and decreased angry attributions (see chapter 3). Taken together, our findings suggest that negatively perceived faces – more dominant or angrier – were rotated further down to look more cooperative. It is possible that dominant people display head posture that is tilted up to reinforce higher social status. Thus, in order to look more cooperative 3D images of such individuals would be rotated further downwards. This explanation supports the interpretation that bowing the head down is interpreted as a demonstration of willingness not to dominate the interaction.

Increasing participant power status decreased the importance of head posture in order to overcome negative expressions. High power individuals were unaffected by counterparts' facial appearance while individuals judging themselves as low in physical and social dominance were affected by the faces of counterparts and required greater downwards rotation of the head when it appeared hostile. This downward posture may provide a greater confirmation of the cooperative intention in hostile looking faces. Thus, perceivers' characteristics as well as counterpart facial aspects influenced the head posture maximizing cooperative appearance.

The different importance of the head tilt for the appearance of cooperativeness based on both counterparts' and perceivers' characteristics further strengthens the idea suggested in chapter 2 that bowing the head is an important display of cooperation and is associated with signalling submissiveness or willingness not to dominate the interaction. This cue has particular importance for individuals that have

a low power status position. Such individuals might be more attentive to the subtle cues signalling status (Watkins, Jones, & DeBruine, 2010) or trustworthiness (Stirrat & Perrett, 2010) that can impact on a potential interaction. For cooperation, a display of lowering the head is expected as a confirmation that an individual is not a threat. It will be interesting for future research to establish whether the postural cue is used as a signal for cooperation in natural social interactions. Indeed there may be an association between displays for cooperation and power status that parallels the relation between status and pride displays (Tracy & Matsumoto, 2008) demonstrated unconsciously in everyday situations.

## Conclusion

To summarise, the analysis presented in this chapter strengthens and at the same time refines the findings on nonverbal postural cues influencing attribution of personality traits. Bowing the head down appears to characterise or symbolise cooperativeness. The postural cue may be interpreted as a demonstration of a subordinate status: a willingness to adopt a role that does not dominate the interaction. The importance of the cue varies for the perceiver based on his/her dominance. Perceivers require a display of the subordinate attitude when they are potentially in a vulnerable position.

# Chapter 5

*Head posture and gaze direction effects on attribution of cooperativeness*

## Abstract

Gaze direction has an important role in social learning and interactions as well as understanding of others' intentions. Previous experiments show that gaze direction influences social attributions such as dominance and attractiveness. We examined the importance of direct gaze in cooperativeness perception. Participants were asked to select the more cooperative image from a pair of images depicting the same individual but with vertically varying gaze direction and head orientation. Our results suggested that gaze looking eye to eye (0°) or gaze looking slightly downward (eye to mouth, 3° down) were perceived as more cooperative than gaze deviating up or down by a larger amount; suggesting that in social trait attributions direct gaze is interpreted as a positive signal of attentional engagement. The preference for direct gaze may have evolved as a pro-social signal which facilitates partnership – both in mating effort and in cooperation more generally.



Keywords: cooperation, head posture; gaze direction

## Introduction

Gaze following and the right interpretation of gaze direction are adaptive in various situations. Correct interpretation of gaze direction has an important role in social learning, social interactions and understanding of others intentions (e.g. Baron-Cohen & Cross, 1992; Calder et al., 2002; Tomasello, Hare, Lehmann, & Call, 2007). Gaze direction, as a regulator of social interactions and understanding of other's intention, can assist discriminating genuine from manipulative cooperators. This skill is vital as cooperation in the long term leads to mutual benefits and prevents exploitation. Little is currently known about the role of gaze direction in perception of cooperativeness. Nonetheless, it is suggested that gaze direction affects perception of dominance (e.g. Main, Jones, DeBruine, & Little, 2009), attractiveness (e.g. Ewing, Rhodes, & Pellicano, 2010; Mason, Tatkow, & Macrae, 2005) and emotional expression (e.g. Adams & Kleck, 2003, 2005), all of which influence cooperativeness attributions. Thus, we set out to address if gaze direction affects cooperativeness.

Viewing another person's gaze (Driver et al., 1999; Friesen & Kingstone, 1998) or head orientation (Langton, Watt, & Bruce, 2000) facilitates a shift of attention to where the other person is looking or facing even in a situation when the other's orientation is irrelevant. This "gaze cuing" effect is shown to influence personality judgements important for choice of cooperative partner. For example when participants were given a task of reacting to a peripheral target, faces that always looked towards that target were subsequently judged to be more trustworthy than faces whose eyes always looked away from the target (Bayliss & Tipper, 2006).

Not only gaze cueing is demonstrated to have an impact on personality judgements but also gaze direction per se affects perception of personality traits affecting cooperativeness judgements. Several studies have demonstrated a preference for direct as compared to averted gaze when judging the attractiveness or likability of neutral (Ewing, et al., 2010; Mason, et al/, 2005) or smiling faces (Conway, Jones, DeBruine, & Little, 2008; Jones, DeBruine, Little, Conway, & Feinberg, 2006). Often this preference is interpreted as signalling social interest and pro-social regard and thus functioning as an efficient mechanism for allocation of mating effort (Conway, et al., 2008).

Additionally, gaze direction affects dominance judgements. Images with direct gaze are perceived as more dominant than images with averted gaze (Main, et al., 2009). This effect is increased for masculinised faces. Important for the purpose of the current study, dominance is expressed through variations in head and gaze direction along the vertical axis in primates (Darwin, 1872/1965, Lorenz, 1966). Lowering the head and the gaze, respectively, is perceived as signalling submissiveness. This expression of power is also observed in humans. Male faces with direct gaze are perceived as more masculine than faces with lowered gaze (Campbell, Wallace, & Benson, 1996) and increasing masculinity in male faces, increases the perception of dominance (DeBruine et al., 2006; Perrett et al., 1998).

Collectively, these findings suggest that mechanisms regulating detection of gaze direction may function to identify potentially cooperative individuals that have pro-social regard for the observer and to identify potentially exploitative individuals that might be dangerous because of high dominance. The human eye region has a specific morphology and colouration (white sclera) which makes it easier to advertise

gaze direction (Kobayashi & Kohshima, 2001). We investigated whether gaze deviations along the vertical dimension affect judgements of cooperativeness. To our knowledge, no previous research has addressed the importance of gaze direction along this dimension on trait perception. We employed a force choice paradigm in which we presented image pairs of the same individual with variations in the gaze direction and asked the participants to select the more cooperative one. We compared images with two different head position – no head tilt (level) and head tilt 3° down. In this way, we were able to manipulate gaze direction more realistically (as compared to experiment 2 in chapter 3) and address the independent effects of head position and gaze direction in attribution of cooperativeness. It is possible that since direct gaze increases dominance perception, direct gaze might be avoided when judging cooperativeness. Alternatively, to perceive an individual as cooperative, a signal of engagement of attention may be required and thus direct gaze may be judged as cooperative.

## Method

### Participants

Forty-five (18 males, age range 18 - 22 ($M$ = 19.36, $SD$ = 1.01) participants took part in the experiment. The study was approved by the University Teaching and Research Ethics Committee at the University of St Andrews (PS6929). All of them provided informed consent and participated as a part of a course fulfilment. Data from one participant were excluded since the data were not correctly recorded, thus resulting in 44 participants.

Materials

Photography

Eighteen (9 males) Caucasian students (age range 18 – 24, *M* = 21.54, *SD* = 1.55) photographed with a 3D camera (3dMD, for technical details see http://www.3dmd.com/3dmdface.html) while looking at different directions expressed in degrees of deviation from direct gaze (**up 6°, down 6° and direct gaze 0°)** were pre-processed following the procedure described in chapter 3. During image acquisition participants were asked to fixate different markers without changing their head orientation. Six experimental identities (3 males) were created by blending 3 same-sex individuals looking at the same direction (see Coetzee et al., 2012). Blends were used as stimuli because they are not identifiable with any individual.

Stimuli calibration

To define a reference head and gaze position in the vertical plane for each stimulus, 20 participants (10 males, age range 18 - 32, *M* = 22.5, *SD* = 3.68) were asked to manipulate the head models so that the faces were 'looking directly at them'. A chin rest was used to guarantee that the viewing angle for all participants was equivalent. The average angle judged as direct gaze for each head models was defined as the approximation of 0° of head rotation. Agreement on the angle as a direct gaze for each image was high (Cronbach's $\alpha$ = .86; N = 18).

Stimuli creation

Head posture can influence the perception of gaze direction (Langton, 2000). Working with 3-D models allowed us to circumvent this possible confound and to ensure that models with different gaze direction had identical head orientation. Our model heads were comprised of a depth map defining the 3-D head surface and a colour texture map defining the colour at each point on the head surface (see also Figure 3-2, p.53). This means that the surface colour of the eye-region from one model (eyes looking up 6°) can be transferred to another (eyes looking direct 0°) while maintaining an identical head structure and head posture. In this way patches were cut from the texture maps corresponding to the eye region (e.g. eyes looking up 6°) and re-inserted in the same head model that was previously aligned at head level. This procedure was performed with Psychomorph software (Rowland & Perrett, 1995; Tiddeman, Burt, & Perrett, 2001). The procedure was repeated for the three possible gaze variations – direct gaze, gaze up 6° and gaze down 6°. In that way, the gaze direction was manipulated without varying the head tilt. From the newly created head models 2D pictures were displayed with head level and a head tilt corresponding to 3° down as experimental stimuli (see Figure 5-1 for image creation). The images with downward tilt were produced by rotating the 3D model along the vertical dimension.

Procedure

Participants were presented with two images of the same individual varying in gaze direction (*relative to the head orientation*: 0°, 6° down, 6° up) for both head tilts (head level, head 3° down). For each experimental head model, there were seven

comparisons with head and gaze specified *relative to the observer* (**head level**: direct gaze vs gaze 6° down and direct gaze vs gaze 6° up; **head 3° down**: gaze 3° down vs gaze 3° up and gaze 3° down vs gaze 9° down). Four of the comparisons corresponded to Figure 1, column 3: row 2 vs row 1 and row 3; and column 4: row 2 vs row 1 and row 3. The other three comparisons corresponded to Figure 5-1 for row 1, 2, and 3: column 3 vs column 4 (an example of the conditions is provided in Appendix B, see also Table 1). Trial order and side of the screen on which any image of the pairs was presented were randomised. Each pairs stayed on the screen until a response was given. Participants were instructed to select the image that looked more cooperative from each pair. A chin rest was used.

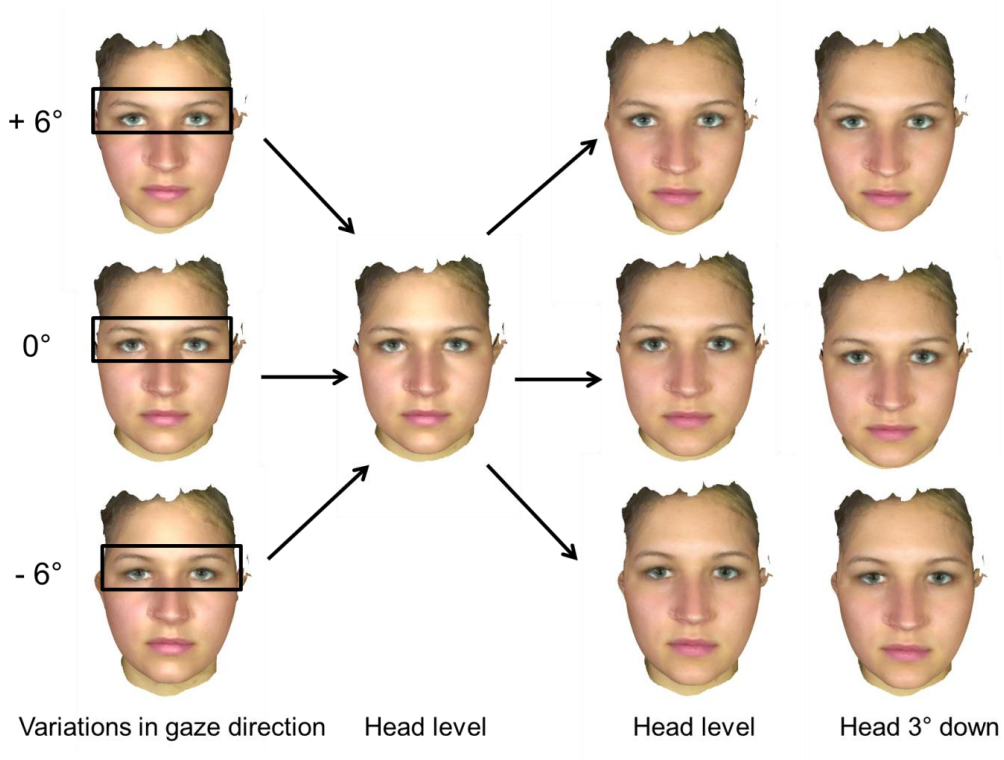


Figure 5-1. Stimuli creation. Column 1: 3D head models with varying gaze direction (top image: 6º up, mid image: direct, bottom image: 6º down). Column 2: Patches corresponding to the eye region are automatically cut and inserted into a previously aligned head model with direct gaze (Column 3)' 3D model is rotated 3º down (Column 4). Note: the eyebrows were also included in the eye patch.

## Results

The mean proportions of chosen images for each experimental combination of gaze direction for the two head positions were calculated (see Table 5-1). The proportion of trials when participants choose images with direct gaze as more cooperative was compared against chance level of 0.5 (i.e. random choice). Since data was not normally distributed (Kolmogorov-Smirnov test: all $Z > .17$ all $p$s $< .003$), Wilcoxon sign ranked tests were performed (multiple comparison correction $p = 0.007$).

Table 5-1. Median scores for the proportion of selected images for all comparisons. Highlighted is the manipulation (head posture or gaze direction relative to the observer) that differs between the two pairs. (* indicates preferences significantly different from chance level at $p < .0001$)

| Head posture – gaze direction | | | Median score |
|---|---|---|---|
| Head: direct - Gaze: **level 0°** | vs | Head: direct - Gaze: **up 6 °** | .67 vs .33 * |
| Head: direct – Gaze: **level 0°** | vs | Head: direct - Gaze: **down 6 °** | .83 vs .17 * |
| Head: down 3° - Gaze: **down 3°** | vs | Head: down 3° - Gaze: **up 3°** | .67 vs .33 * |
| Head: down 3° - Gaze: **down 3°** | vs | Head: down 3° - Gaze: **down 9°** | .67 vs .33 * |
| Head: **direct** - Gaze: level 0° | vs | Head: **down 3° -** Gaze: down 3° | .50 vs .50 |
| Head: **direct** - Gaze: down 6° | vs | Head: **down 3°** - Gaze: down 9° | .50 vs .50 |
| Head: **direct** - Gaze: up 6° | vs | Head: **down 3°** - Gaze: up 3° | .50 vs .50 |

Head level

The analysis for head level images showed that direct gaze was perceived as more cooperative significantly more often than chance (each comparison $Z$s $\geq$ - 4.86, ps $< .0001$), indicating that participants choose more often as more cooperative

images with direct gaze (*Median* = 0.67) than gaze 3° up (*Median* = 0.33). Similarly, direct gaze (*Median* = 0.83) was selected more often as more cooperative than gaze 6° down (Median = 0.17).

Head 3° down

Similar results were revealed when the head was tilted 3° down (each comparison Zs ≥ - 3.67, ps < .0001). Participants choose as more cooperative the images with gaze 3° down (*Median* = 0.67) compared to images with gaze deviation of 3° up (*Median* = 0.33) or 9° down (*Median* = 0.33).

Head level vs Head 3° down

The proportion of images chosen with head tilted 3° down did not differ from chance level for all three comparisons across the different gaze directions (*p*s > .18), suggesting that there was no preference for head 3° down or head level for all gaze directions - gaze 6° up, direct gaze or 6° down (*relative to the head orientation*).

## Discussion

We investigated the effects of gaze direction on perception of cooperativeness. Specifically we evaluated how gaze in the vertical axis affected attributions. Across two head positions, our results clearly demonstrated that images with direct gaze are judged as more cooperative than images with vertically averted gaze. Direct gaze is preferred when judging cooperativeness. This effect is most likely due to eye contact being a strong indicator of attention directed at the observer (Perrett & Emery, 1994). Mutual attention between two parties can be regarded as prerequisite for cooperation.

We speculate that since the trait assessment is thought to be a process of generalizing whether to approach or avoid someone (Todorov, 2008), signalling approachability by looking at someone is interpreted as increasing cooperativeness. Direct gaze is more closely related to approach behaviour than averted gaze (cf., Adams & Kleck, 2003, 2005). Eye contact and averted gaze influences neural mechanisms regulating approach avoidance behaviour (Hietanen, Leppänen, Peltola, Linna-aho, & Ruuhiala, 2008). Furthermore, seeing direct and averted gaze activates structures – posterior superior temporal sulcus and medial prefrontal cortex – thought to be involved in reading other's intentions (e.g. Calder et al., 2002).

The preference for direct gaze when judging cooperativeness are similar to judgments of attractiveness and likeability (Conway, et al., 2008; Ewing, et al., 2010; Jones, et al., 2006; Mason, et al., 2005). Attractive faces with direct gaze activate brain areas involved in processing reward (Kampe, Frith, Dolan, & Frith, 2001) and structures that are activated during cooperative endeavours (e.g. Rilling et al., 2002; Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004). Thus, willingness to reciprocate as indicated by direct gaze might enhance the activation within these structures. Contrary to expected, we did not find any evidence that direct gaze increased perception of dominance and exploitation. Taken together, the current and previous research suggest that direct gaze can demonstrate a pro-social signal which facilitates positive social interactions in the context of mate choice or more general cooperation.

Gaze 3° down was seen as more cooperative than gaze 3° up or gaze 9° down. People have a very liberal criteria as what is considered to be looking at them (Gamer & Hecht, 2007), thus it can be speculated that gaze 3° down is considered within the cone of direct gaze (the space perceived as looking at someone). If gaze 3° down is

perceived as eye contact, this gaze may signal social engagement. Considering the focus of attention during social interactions helps explain why this is so. Gaze 3° down is roughly equivalent to looking at the mouth for individuals separated by 1 m. Looking at a person's mouth might help comprehension of their speech and emotional expressions (e.g. Caldara et al., 2005) hence gaze 3° down can be considered directing attention towards that person. By contrast, gaze 3° up is roughly equivalent to looking at a person's hairline and is likely to be interpreted as inattentive and disengaged. Gaze 9° down will also lie outside the cone of direct gaze and is likely to be interpreted as gaze avoidance and/or a lack of attention.

Contrary to our previous findings, in the current experiment we did not find any differences in the preferences for direct head posture and head bowed 3° down. Several differences in the design of the two experiments can account for the results. In the first 2 studies the participants manipulated 3D images. The findings reported based on them can be a result of the dynamic action of tilting the head down. It is possible that the static final head tilt is not the cue to cooperation but rather the dynamic movement of lowering the head cues cooperation. Future experiments can address this question by devising an interactive experiment using 3D head models that maintain their eye contact whilst the head posture is manipulated by the participant. Additionally, in the current experiment, in the conditions comparing the two different head posture, the viewing gaze directions also differed. The inconsistency between the two cues- head posture and gaze direction might have impacted the results. It is also possible that head posture is a subtle cue impacting cooperativeness perception while gaze direction is more powerful and attenuates the effects of head posture.

## Conclusion

We find clear evidence that faces displaying eye contact are considered more cooperative than those subtly averting the gaze. Direct gaze can be interpreted as a pro-social signal demonstrating interest and engagement that has a beneficial role in facilitating joint effort in establishing partnerships.

# Section 2: Trustworthiness

## Chapter 6

### *Impact of cues to health on perceived trustworthiness*

This chapter is based largely on work that has been submitted to a peer-reviewed journal:

Dzhelyova, M., Lefevre, C. E., & Perrett, D.I. Trusted and attractive? Cues to health impact perceived trustworthiness and attractiveness. *Social Psychological and Personality Science*

## Abstract

In line with evolutionary theory and the 'behavioural immune system', cues to health are crucial for mate choice and for judgments of who to trust in social interactions. Skin colour cues current health, while masculinity may cue long-term health but is also associated with negative personality traits (e.g. uncooperativeness). We therefore investigated the contributions of facial skin colour and masculine face shape to attractiveness and trustworthiness perception. Male faces were manipulated in both skin colour (healthy/unhealthy) and face shape (feminine/masculine). Healthy colour increased attractiveness and trustworthiness ratings. Feminine-shaped faces were perceived as more trustworthy while masculine shaped faces were perceived as more attractive. Attractive male faces either had a healthy colour or a masculine-shape, but possession of both characteristics did not elevate attractiveness further, suggestingnon-additive effects of the two cues. The results support the notion of a behavioural immune system and indicate that the interplay between cues for mate choice is more complex than previously thought.



Keywords: trustworthiness; attractiveness; health cues; sexual dimorphism

## Introduction

Individual differences in facial appearance affect judgements of attractiveness, personality, and even behaviour. For example, previous research demonstrates high agreement in judgements of attractiveness (e.g. Langlois et al., 2000), as well as attributions of behavioural traits such as aggression (e.g. Carré, McCormick, & Mondloch, 2009) and trustworthiness (e.g. Stiratt & Perrett, 2010). While most work to date has examined the influence of face shape on these characteristics, more recently the impact of facial skin status on attractiveness and health has become apparent (e.g. Scott et al., 2010; Stephen et al, 2009). There is evidence that skin colour has an effect on attractiveness that is independent of face shape (Stephen et al, 2009), although, it is currently not known if facial morphology and skin colour interact or have an additive effect in optimising the mate quality inferred from these physical cues. Skin colour, a putative measure of current health (e.g. Stephen et al, 2009), may have more far reaching effects on social judgments influencing, for example, trustworthiness perception because people may be more willing to engage in social interactions when risk of infection is low (Schaller & Park, 2011). We therefore investigated the impact of healthy facial skin colour and masculine face shape on the perception of both attractiveness and trustworthiness in males.

Female mate preferences are thought to be based on direct (i.e. parental investment; resource availability; good health) or indirect (i.e. good genes) benefits accrued from the male (e.g. Trivers, 1972; Zahavi, 1975). Sexually dimorphic male facial shape may act as a cue to both these benefits. Firstly, facial masculinity has been linked to a better medical history (Rhodes, Chan, Zebrowitz, & Simmons, 2003), and shorter durations of past illnesses (Thornhill & Gangestad, 2006), indicating an

association with general long-term health. Consistent with this is a role of testosterone in contributing both to facial masculinity (Pound, Penton-Voak, Surridge, 2009) and a strengthened immune response (Rantala et al., 2012). Secondly, prominent male-typical facial features (e.g. prominent brow ridges, broad chin) increase dominance perception (e.g. DeBruine et al., 2006; Perrett et al., 1998) and are often seen as a cue to physical strength and social status (Fink, Neave, & Seydel, 2007; Mueller & Mazur, 1997), linking masculinity to direct benefits through ability to acquire resources. Despite these observations, female attraction to masculine-shaped faces is equivocal to date with some studies finding this preference (e.g. DeBruine et al., 2006) but others finding preferences for feminine facial features (e.g. Perrett et al., 1998).

While effects of facial masculinity on social judgements and mate choice are well investigated, the impact of skin colouration has been largely neglected. This paucity in the literature is unfortunate because skin colouration has been linked to facial attractiveness, perhaps as a cue to current health (e.g. Scott et al., 2010; Stephen et al., 2012) thus indicating direct benefits (i.e. low pathogen load and an ability to acquire resources). In particular, skin yellowness, which is associated with levels of carotenoids (potent antioxidants), may indicate current health status: carotenoid levels can change in response to dietary changes (Stahl et al., 1998; Whitehead et al., 2012) and parasite infestation (Koutsos, Calvert, & Klasing, 2003).

It follows that skin colour may also affect other social judgements. Social interactions offer great interpersonal benefits but at the same time pose a potential risk of infection, since many diseases are transmitted as a result of proximity to or contact with another person. In line with this trade-off groups of people that may bear particularly high pathogen loads are associated with negative prejudice (e.g. Park,

Faulkner, & Schaller, 2003). Further research suggests a positive association between levels of parasite stress in the environment and strength of in-group favouritism (Fincher & Thornhill, 2012) thus providing additional support for a pathogen-avoidance strategy in social life.

From this perspective, then, such facial cues that denote current pathogen load (i.e. skin colour) may be important when deciding who to engage with in social interactions. In addition, there may be material benefits to interactions with healthy people. Healthy individuals will tend to live longer and accumulate more resources during their lifespan. Thus, cooperation with healthy individuals may produce a higher pay-off than cooperation with unhealthy partners. Indeed, in an economic game people reciprocated with apparently healthy partners more than unhealthy partners, though initial trust decisions were unaffected by apparent health (Krupp, DeBruine & Jones, 2011).

## The present study

In order to better understand the impact of face shape and colour on social judgements, in the current study we sought to establish the differential influence of healthy skin colouration and masculine shape on the perception of attractiveness and trustworthiness of male faces. The perception of trustworthiness as a social judgement is of particular interest because it has been proposed as a key predictor of a range of assessments about other people's personality, appearance and emotional state (Oosterhof & Todorov, 2008), and thus is crucial for social interactions and survival. Since skin colour is used as a cue to health (Stephen et al., 2009), which is beneficial for both mate choice and social interaction, we expected healthy skin colour to positively affect both attractiveness and trustworthiness ratings irrespective of face

shape. Previous research has suggested that masculine-shaped faces are perceived as less emotional, honest and cooperative as compared to feminine-shaped faces (Perrett et al., 1998); importantly, they are also trusted less (Oosterhof & Todorov, 2008), thus we anticipated facial masculinity to decrease trustworthiness perception. We were further interested in establishing a possible interaction between face shape and face colour in attractiveness judgements. Thus, we independently manipulated faces along two axes: skin colour (healthy – unhealthy) and face shape (masculine – feminine), creating four versions of each face. All versions of each face were rated for both attractiveness and trustworthiness.

## Methods

### Participants

One hundred and five (30 male) heterosexual [5] participants, age range 18 – 39 years ($M$ = 26.17, $SD$ = 4.93) completed an online experiment. The study was approved by the by the University Teaching and Research Ethics Committee at the University of St Andrews (Approval code: PS7430 and PS9129).

[5] Research on mate choice preferences of heterosexual and homosexual participants suggests that attractiveness judgements based on shape variations of same sex faces made by homosexual and those made by heterosexual individuals of the opposite sex faces are not identical (Glassenberg, Feinberg, Jones, Little, & DeBruine, 2010). Therefore, only heterosexual participants were included in the sample, which resulted in the exclusion of 16 participants. Including these participants did not have an impact on the results.

**Stimuli**

Stimuli consisted of 12 male identities that were each created by combining five images of Caucasian males (*M* = 22.3 years, *SD* = 7.75 years) and manipulated both in shape (masculine / feminine) and colour (healthy looking / unhealthy looking) resulting in four versions of each identity. Identities were shape transformed by applying ±50% of the linear difference between Caucasian male and female averages, creating a masculinised and a feminised version of each identity (for details see Tiddeman, Burt, & Perrett, 2001).

Shape-transformed stimuli were then colour transformed following previous work showing that added skin yellowness increases health perception (e.g. Stephen et al., 2009). We therefore manipulated all faces to be more or less yellow by adding and subtracting ±8.7 units of yellowness (b* in the CIELab colour space, see Stephen et al., 2009 for details) in all faces). This value was derived from a pilot experiment which had shown that on average this amount of yellowness was added to Caucasian faces to make them appear most healthy. Images were cropped so that only the face was visible (see Figure 6-1).

Figure 6-1. A) Endpoint masks representing differences in fruit and vegetables consumption (left: more fruit and vegetables; right: less fruit and vegetables). Note: Colour differences are applied to the whole face except for the eyes. 5 pixel Gaussian blur is applied for a smoother colour transition. B) Examples of experimental images (left to right: masculine shape, healthy colour; feminine shape, healthy colour; masculine shape, unhealthy colour; feminine shape, unhealthy colour).

## Procedure

Stimuli were divided into four sets of 12. Each set comprised one version of each identity (e.g. feminine shaped and healthy coloured). Participants rated only one set of stimuli so that they would not see the same identity twice. Ratings were made on a 7-point Likert scale for attractiveness (1 - not very attractive; 7 - very attractive) and trustworthiness (1 - not very trustworthy; 7 - very trustworthy) in two independent blocks. Image presentation within each block and block order was randomised. Images remained on the screen until participants responded.

## Results

For each participant, the averaged attractiveness and trustworthiness ratings for each combination of skin colour and face shape transformations were calculated. A mixed ANOVA with rating type (attractiveness; trustworthiness), face shape (feminine; masculine) and face colour (healthy; unhealthy) as within-subject variables, and participants' gender (female; male) as a between-subject variable was performed on the mean ratings given by the participants. Effect sizes are provided by reporting partial eta² and Pearson's correlation coefficients.

As expected, a main effect of face colour, $F(1,103) = 15.63$, $p < .0001$, $\eta_p^2 = .13$, $r = .36$, suggested that stimuli with healthy face colour ($M = 3.64$, $SEM = .08$) were rated as more attractive and trustworthy than those with unhealthy face colour ($M = 3.36$, $SEM = .09$). This effect was greater in attractiveness as compared to trustworthiness ratings (although both $ps \leq .011$) as indicated by a significant interaction between face colour and rating type, $F(1,103) = 8.28$, $p = .005$, $\eta_p^2 = .07$, $r = 0.27$ (see Figure 6-2A). An interaction between rating type and face shape, $F(1,103) = 9.74$, $p = .002$, $\eta_p^2 = .09$, $r = .29$ indicated that while shape-masculinised faces were rated as more attractive, they tended to be judged as less trustworthy compared to a feminised face shape (see Figure 6-2B).

There was an interaction between face shape and face colour, $F(1,103) = 7.12$, $p = .009$, $\eta_p^2 = .06$, $r = .25$ which was further qualified by a three-way interaction among rating type, face shape and face colour, $F(1,103) = 4.59$, $p = .034$, $\eta_p^2 = .04$, $r = .21$. Post-hoc analysis indicated that the interaction between face shape and face colour was present in attractiveness ratings, $F(1,103) = 11.59$, $p = .001$, $\eta_p^2 = .10$, $r =$

.32 but not in trustworthiness ratings, $F(1,103) = .11$, $p = .736$. For feminine-shaped faces, healthy looking colour was rated as more attractive than unhealthy looking colour, $t(104) = 7.67$, $p < .0001$, $r = .60$ but healthy looking colour did not influence masculine-shaped faces ($p = .18$ see Fig. 6.3). Alternatively, for healthy looking coloured faces, shape of the face had no effect ($p = .72$), but for unhealthy looking coloured faces, masculine faces were rated as more attractive than feminine faces, $t(104) = 5.83$, $p < .0001$, $r = .50$).

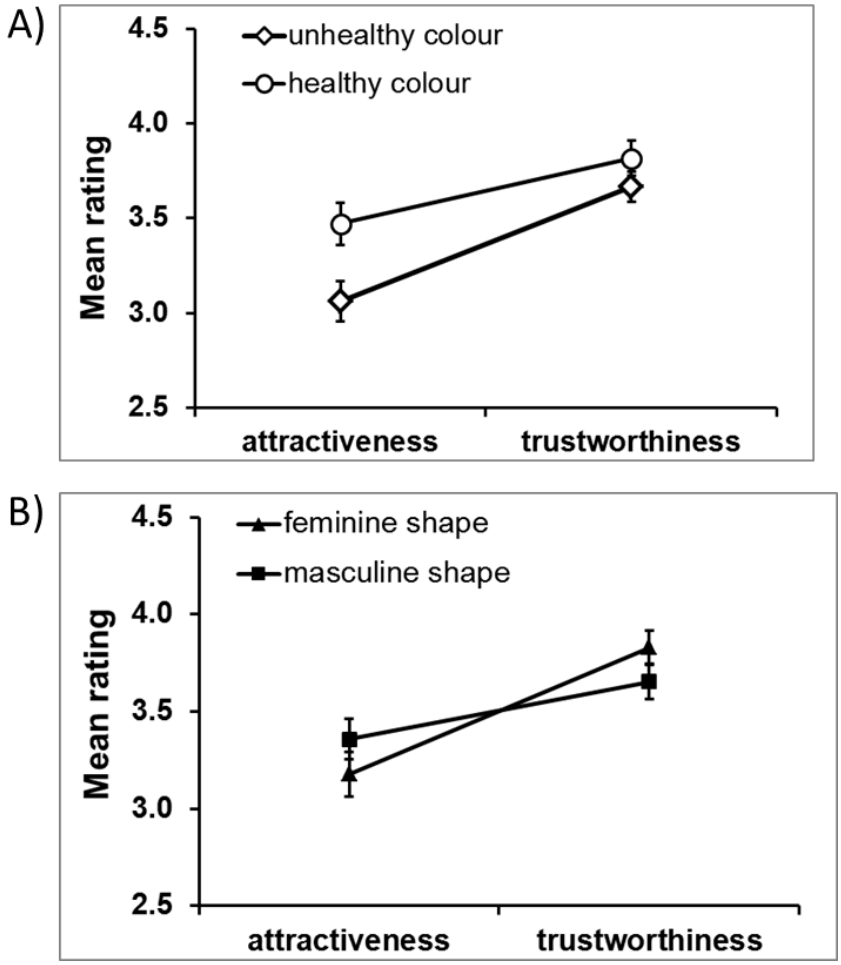


Figure 6-2 A). Mean rating (and SEM as error bars) on a 7-point Likert scale - 1 (very unattractive/ very untrustworthy) to 7 (very attractive/very trustworthy - given by the participants as a function of rating type (attractiveness; trustworthiness) and face colour (healthy; unhealthy). B). Mean rating (and SEM as error bars) given by participants as a function of rating type (attractiveness; trustworthiness) and face shape (feminine; masculine).

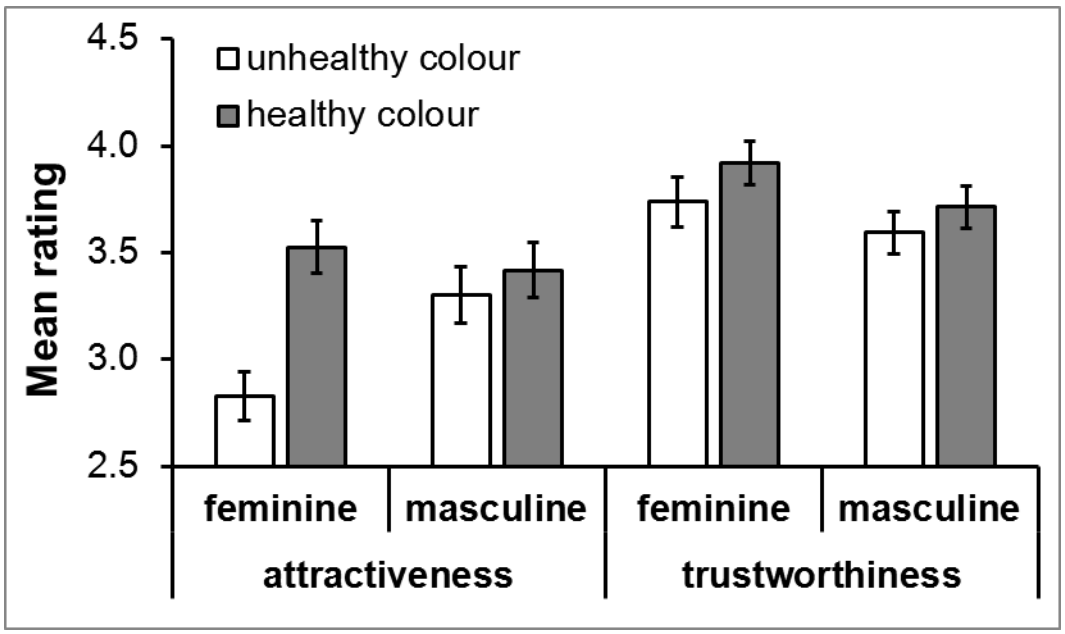


Figure 6-3. Mean ratings (and SEM as error bars) of face colour (healthy; unhealthy) and face shape (masculine; feminine) for each of the attractiveness and trustworthiness judgements.

Finally, a main effect of rating type, $F(1,103) = 23.29$, $p < .0001$, $\eta_p^2 = .18$, $r = .43$, indicated that on average trustworthiness ratings ($M = 3.74$, $SEM = .07$) were higher than attractiveness ratings ($M = 3.27$, $SEM = .10$). No other main effects or interactions reached significance.

## Discussion

Here we present evidence for context-dependent differences in the importance of shape and colour cues in male faces. We investigated the effects of health-linked skin colour and sexually dimorphic face shape on the perception of both attractiveness and trustworthiness. Our results indicate that healthy looking skin colour positively influences both trustworthiness and attractiveness. In line with previous work, we further found that masculine face shape is seen as more attractive, while feminine face shape is perceived as more trustworthy. Perhaps more notably, we present evidence

suggesting that masculine face shape and healthy skin colour are independently sufficient cues to facial attractiveness. For a male face to be considered attractive either shape masculinity or healthy colouration need to be present; however, the presence of both these cues does not additionally elevate attractiveness. Hence, colour and shape interact in facial attractiveness judgments: healthy skin colour elevates attractiveness only in those faces with a feminine shape; conversely masculinity is more attractive only in faces with an unhealthy skin colour.

The perception of masculine-shaped and healthy coloured faces as attractive is in line with some previous work (e.g. Stephen et al., 2012; Scott et al., 2010), although there is equivocality with regards to masculine shape cues and perceived attractiveness (e.g. Debruine et al., 2006; Perrett et al., 1998). Both masculine face shape and healthy skin colour are thought to signal health, with face shape acting as a cue to long-term and developmental health (e.g. Rhodes, et al., 2003; Thornhill & Gangestad, 2006) and skin colour indicating current health (e.g. Scott et al., 2010). Furthermore, our results indicate that current health status is particularly important in those males that do not exhibit cues of good genes or status (i.e. masculine facial structure). If facial masculinity is present as a possible cue to long-term immunity and health (Rantala et al., 2012; Rhodes et al., 2003) the current health state of an individual may be less predictive of survival. Conversely, individuals with a relatively poor general predisposition, as potentially exhibited by feminine face shape, may also be valuable mates, but only if they are in good current health. Skin colour would then be a pivotal cue of quality in these individuals.

The influence of healthy face colour on trustworthiness judgments found here suggests that apparent current health influences trust decisions. Healthier individuals may pose a better investment both in a social and economic sense. They live longer

and will likely acquire more resources throughout their lifespan as compared to less healthy individuals. In addition and perhaps more importantly, healthy people may be preferred as partners for social interactions *per se*, because they are less likely to carry and pass on illnesses (Schaller & Park, 2011). Contrary to Krupp et al. (2011), our data indicate that cues to current health increase perceived trustworthiness. This discrepancy could be due to differences in the measures of trust and health used. We asked our participants to rate trustworthiness while Krupp et al. (2011) measured trust by assessing investments made in a partner. It is worth noting that even though the measures are different, trustworthiness perception is concordant with behaviour in economic games (e.g. Stirrat & Perrett, 2010) and, as such, similar outcomes can be inferred. Additionally, manipulating skin colour as an approximation of current health, as opposed to utilising general health ratings, should be less confounded by uncontrolled cues to long-term health (weight; masculinity) and facial expression. It is also possible that the manipulation of the images led to unintended changes of the stimuli that might have an impact on the results (increased contrast between the lips and the eyes or lighter facial hair), however we think that this explanation is less likely to have led to our results. Future experiments should address this possibility.

Consistent with previous studies showing that facial masculinity increases the attribution of negative personality traits (e.g. Perrett et al, 1998); we found that masculine face shape appeared to be perceived as less trustworthy than feminine face shape. The converse effect of masculinity on attractiveness and trustworthiness perception may suggest a context-dependent utilisation of cues associated with more than one relevant trait. For example, in mate choice masculinity provides cues to good health and status (desirable traits in a mate), while in social attributions, it is mainly used as a cue of dominance (an undesirable trait in a trading partner given the risk of

exploitation, Stirrat & Perrett, 2010). The dissociation in the perception of masculine males as more attractive but less trustworthy, reported here, challenges previous findings of an elevated positive perception or 'halo effect' of attractive individuals (for review see Langlois et al., 2000).

## Conclusion

In summary, the results presented here indicate that facial cues to partner's quality may be interdependent and that the importance of facial cues is contingent on the social judgement made. We demonstrate that skin colour, as a cue of current health, impacts trustworthiness perception. In line with recent work on the behavioural immune system (Schaller & Park, 2011), our work indicates that cues to current health are imperative for social judgements. Additionally, we show that, at least in mate choice, short- and long-term cues to partner's quality interact, indicating that these attributes cannot be understood as independent. These results provide important advances in the understanding of social interactions and mate choice.

# Chapter 7

## *Temporal dynamics of trustworthiness*

This chapter is based largely on work that was published in peer-reviewed journal:

Dzhelyova, M., Perrett, D. I., & Jentzsch, I. (2012). Temporal dynamics of trustworthiness perception. *Brain Research, 1435*(0), 81-90. doi: 10.1016/j.brainres.2011.11.043

The version presented here is not the final print version.

## Abstract

Behavioural and neuroimaging studies suggest that the attribution of trustworthiness to faces relies on emotional and structural cues. Previous research suggests that attributions happen spontaneously and very rapidly but the precise temporal dynamics of the underlying processes are not known. We investigated the temporal dynamics of trustworthiness perception by employing scalp recorded event related potentials and evaluating effects on components previously implicated in face processing: P1 (positive component ~100 ms post-stimulus), N170 (negative deflection sensitive to faces) and a posterior-occipital negativity ~ 230 to 280 ms (early posterior negativity – EPN). Participants judged the gender and trustworthiness of female and male images manipulated to look either more or less trustworthy. The results indicated that facilitated behavioural processing (increased accuracy and shorter reaction time) of socially important stimuli – in particular males that looked untrustworthy (and should be avoided) but also females that looked trustworthy (and who might therefore be useful in cooperative ventures) – was reflected in an increased negativity of N170 amplitude over the right hemisphere. Additionally, trustworthiness continued to modulate the amplitude of the negative deflection ~ 230 to 280 ms post-stimulus during explicit judgements of trustworthiness but not during gender judgements. The results suggest that negativity accompanies the relevance of the faces (female trustworthy and male untrustworthy) that are important to remember for future social interactions.



Keywords: P1, N170, posterior-occipital negativity, trustworthiness perception

## Introduction

Trait attribution models describe personality characteristics by using two dimensions – warmth/emotional valence and competence/dominance (e.g. Fiske, Cuddy, & Glick, 2007; Oosterhof &Todorov, 2008; Wiggins, 1979). The observer is thought to make rapid and automatic assessment of an individual's intentions from the warmth dimension; and make more considered judgments of whether or not the individual is in a position to act upon his/her intentions from the competence dimension. In a recent trait attribution model, the best approximation of the warmth dimension was found to be trustworthiness perception (Oosterhof &Todorov, 2008). Trustworthiness estimation relies primarily on emotionally expressive cues (Todorov, Baron, & Oosterhof, 2008; Krumbhuber, et al., 2007; Zebrowitz, Kikuchi, & Fellous, 2010) but also utilises cues from facial structure (Todorov, et al., 2008; Stirrat & Perrett, 2010).

Exaggerating facial features along the trustworthiness dimensions in computer-generated neutral faces produced emotionally expressive faces (Oosterhof & Todorov, 2009). Untrustworthy faces appear angry and are characterised by V-shaped brows and ∩-shaped mouths while trustworthy faces appear happy and are characterised by the opposite pattern – Λ-shaped brows and U-shaped mouths. Trustworthiness can also be conveyed by variations in structural facial features such as brow ridge, cheek protuberance and chin shape (Todorov, et al., 2008) or facial width (Stirrat & Perrett, 2010). Faces with shallow cheeks, wider chins, lower eyebrows and wider faces are perceived as less trustworthy. Male facial width to height ratio correlates with actual trustworthiness in economic games (Stirrat & Perrett, 2010). The structural features conveying low trustworthiness – shallow

cheeks, low eyebrow ridge (Enlow & Hans, 1996) and increased facial width (Weston, Friday, & Liò, 2007) appear to be sexually dimorphic. Female individuals have more pronounced cheekbones, the eyebrow ridge is higher and their faces are narrower. Additionally, increasing masculinity in faces decreases their perceived cooperativeness and trustworthiness (Buckingham, et al., 2006; Oosterhof & Todorov, 2008; Perrett, et al., 1998), thus it can be speculated that sex and trustworthiness are not entirely independent dimensions.

Even though trustworthiness judgements affect social and economic interactions, people's first impressions are consistent with judgements made at longer viewing duration (Todorov, Pakrashi, & Oosterhof, 2009; Willis & Todorov, 2006). Trustworthiness can be processed even when faces are presented briefly in situations that prevent an elaborated conscious experience (Todorov, et al., 2009). When very briefly primed with either a trustworthy or an untrustworthy face, participants' perception of a subsequently presented neutral face is biased towards the trustworthiness level of the prime. Taken together, the findings suggest that the process of trustworthiness attribution happens spontaneously and fairly automatically.

Converging evidence for the automaticity of trustworthiness judgements is available from the neuroscience literature. While performing a face memory task (Engell, Haxby, & Todorov, 2007) or age judgements (Winston, Strange, O'Doherty, & Dolan, 2002) of faces varying in trustworthiness, the amygdala activation increased as the trustworthiness of a face decreased suggesting an automatic involvement of the structure in implicit trustworthiness judgments. The amygdala is generally implicated in processing emotionally and socially relevant information (for an overview see Adolphs, 2010) and is suggested to assess rapidly a stimulus's emotional valence and

to feed backwards to the cortical regions involved in early stages of visual perception within the ventral stream (Adolphs, 2002; Sato, Kochiyama, Yoshikawa, & Matsumura, 2001; Vuilleumier & Pourtois, 2007). Patients with bilateral amygdala damage show abnormal judgements of trustworthiness and approachability for faces (Adolphs, Tranel, & Damasio, 1998). They demonstrate a general bias in attributing trustworthiness and approachability even for faces that control subjects judge as untrustworthy. This bias was especially pronounced when the most untrustworthy faces were evaluated. Additionally, some amygdala damaged patients confuse fearful and angry emotional expressions with happy expressions (Sato, et al., 2002). Collectively, these patient studies lend support to the association between emotional expression and trustworthiness attribution.

To sum up, behavioural and neuroimaging studies suggest that ascribing trustworthiness to faces relies on mainly expressive cues. Judgements happen automatically and recruit structures involved in the processing of emotion. Neuroimaging and behavioural measures provide limited information about the time course of the processes underlying trustworthiness attribution. Therefore, event related potentials (ERPs) might be better suited as a method to investigate the exact temporal dynamics of trustworthiness attribution.

A recent study investigated trustworthiness perception employing an ERP paradigm (Rudoy & Paller, 2009). It explored how "perceptual" information (a picture of a face) and "memory-based" information (trait attribution provided by an adjective describing personality) affect trustworthiness perception. The participants were tested in three phases – a learning phase in which images, classified as trustworthy, neutral and untrustworthy based on consensus ratings, were paired with

either a positive or a negative word; a rating phase during which the participants had to judge on a 5-point scale the trustworthiness of the face; and a test phase during which the participants had to recall the words associated with the face. ERPs were recorded during the rating phase of the experiment. Trustworthy as compared to untrustworthy faces evoked greater positivity, 200 to 400 ms post-stimulus – at frontal electrode sites. This modulation may reflect higher cognitive evaluation rather than spontaneous stimulus driven perception. Importantly, the study did not address the relationship between sex and trustworthiness of the face. In order to address the question of the rapidness of trustworthiness attribution and the extent to which trustworthiness perception interacts with the sex of a face and modulates the ERPs evoked by faces, we employed an ERP experiment in which participants were presented with male and female faces manipulated to look trustworthy or untrustworthy and asked to judge either stimulus gender or trustworthiness. We focused our analysis on areas within the occipito-temporal sites implicated in face perception. We evaluated components related to visual and face processing P1and N170. P1 and its magnetic counterpart M100 is often suggested to be face-sensitive (e.g. Batty & Taylor, 2003; Herrmann, Ehlis, Ellgring, & Fallgatter, 2005; Liu, Harris, & Kanwisher, 2002) and commonly influenced by low level visual attributes in facial and non-facial stimuli. Furthermore, the P1 amplitude increases to attended stimuli (Clark & Hillyard, 1996) suggesting that it is a marker of attention allocation. The N170 consistently discriminates faces in comparisons to other visual objects (e.g. Bentin, Allison, Puce, Perez, & McCarthy, 1996; Goffaux, Gauthier, & Rossion, 2003; Rossion et al., 2000; Rousselet, Husk, Bennett, & Sekuler, 2008). It is assumed to represent structural encoding of faces (Bentin, et al., 1996), including configural information of facial features (e.g. Goffaux, et al., 2003, Rossion et al., 1999). Since

we were interested in evaluating the rapidness of the trustworthiness discrimination, we examined the effect of trustworthiness perception on these early components. A modulation of either Pl or N170 would argue that the perception of trustworthiness is very rapid driven by spontaneous stimulus evaluation, rather than evoked by a top down process. Additionally, as mentioned earlier, facial trustworthiness is expressed by variations in changeable (expressive) cues and invariant (structural) aspects of the face and both P1 and N170 are reported to be modulated by emotional expression (e.g. Batty & Taylor, 2003; Martens, Leuthold, & Schweinberger, 2010; Pourtois, Grandjean, Sander, & Vuilleumier, 2004;Williams, Palmer, Liddell, Song, & Gordon, 2006 though see Eimer & Holmes, 2002; Eimer, Holmes, & McGlone, 2003) and facial structure – attractiveness (Halit, de Haan, & Johnson, 2000) and sexual dimorphism (Freeman, Ambady, & Holcomb, 2010) . However, it is important to note that category-specific modulations of these early ERP components, especially the P1, can often be accounted for by variations in low level stimulus features (stimulus contrast, luminance, colour, etc.) between the different stimulus categories (Rossion & Caharel, 2011; Rossion & Jacques, 2008). Therefore, the interpretation of face-sensitive effects on the P1 needs to be conducted with caution.

Another component modulated by emotional expression is the early posterior negativity (EPN) peaking ~ 200 ms. An increased EPN amplitude is reported for faces expressing a happy emotion (Williams, et al., 2006) and negative expressions – fear and anger – (Martens, et al., 2010; Schupp, Junghöfer, Weike, & Hamm, 2003). A similar increased negativity over the posterior visual areas differentiated emotional (happy and fearful) from neutral expressions (Sato, et al., 2001). The EPN is also modulated by the arousing nature of visual stimuli. When people are presented with

images depicting mutilation, threat or an erotic content, the amplitude of EPN is increased (Schupp, et al., 2004). In summary, EPN is modulated by the importance of the stimuli, and salient stimuli cause an increase in this component's negative amplitude. Given the importance of trustworthiness to social interactions we might expect trustworthiness to modulate the EPN evoked by faces. Being able to make trustworthiness judgements quickly is adaptive both for avoiding untrustworthy individuals but also for remembering trustworthy individuals for future cooperation.

To sum up, we investigated the rapidness of trustworthiness perception and focused our analysis on the visual (face-sensitive) components, P1 and N170, and a negative deflection after 200 ms (EPN). More specifically, since sex dimorphism is linked to trustworthiness, we expected any trustworthiness modulation of ERP components to be contingent on sex of the face.

## Method

### Participants

Thirty-nine participants took part in the experiment. Data from 1 participant were not recorded due to technical problems and 6 more participants were excluded from the analysis since they did not meet the minimum criteria of at least 7 correct and artifact-free trials in each analysis cell. Mean accepted trials averaged across participants separately for each experimental condition equalled 30 (*SD* = 5. 4). The remaining 32 participants (16 male), age range 17 – 47 (*M* = 24.0; *SD* = 5.8) were included in the analysis. There was no difference in the age range for female (*M* = 24.2, *SD* = 6.8) and male participants (*M* = 23.81, *SD* = 5.0). All participants were right handed except for three female participant reporting left handedness and one

male reporting ambidexterity. All participants provided signed and informed consent and were paid £8 for their participation. The study was approved by the University Teaching and Research Ethics Committee at the University of St Andrews (Approval code: PS6305).

## Apparatus

The stimuli were presented on an Envy 17-inch (43-cm) CRT monitor controlled by a computer. Participants were seated in a dark room with an 80-cm viewing distance to the screen. The response keys were mounted 15 cm apart in the horizontal plane of the participant.

Electroencephalographic (EEG) activity was recorded using a BIOSEMI Active-Two amplifier system with 72 Ag/AgCl electrodes. Two additional electrodes (Common Mode Sense active electrode and Driven Right Leg passive electrode) were used as reference and ground electrodes, respectively. Vertical eye movements were recorded with two electrodes positioned above and below the eyes. Horizontal eye movements were recorded with electrodes placed at the corner of each eye. EEG and electrooculogram (EOG) recordings were sampled at 256 Hz. Off-line, all EEG channels were recalculated to average reference. Trials containing eye artifacts were corrected using the adaptive artifact correction method of BESA (Ille, Berg, & Scherg, 2002).

## Stimuli

Following an established method of manipulating perceived traits, 180 Caucasian faces (90 male), photographed with standard neutral expression, were transformed to look trustworthy or untrustworthy using prototype-based computer

graphic transformations (Rowland & Perrett, 1995; Tiddeman, Burt, & Perrett, 2001). The prototypes for each sex were created by averaging 10 Caucasian model faces ranging in perceived trustworthiness expressed in SD (for untrustworthy prototypes 4 models with SD = - 8, 4 models with SD = - 6, and 2 models with SD = - 5 were averaged; for trustworthy prototypes the same individuals but with SD = + 8 (4 models), with SD = + 6 (4 models) and with SD = + 5 (2 models) were averaged), developed by Todorov, et al., 2008 using FaceGen software (www.facegen.com). The original faces were transformed + 50 % (trustworthy) or – 50% (untrustworthy) by applying to them linear difference in shape of the same sex prototypes. An oval shape mask was applied so that only the face was seen (see Figure 7-1). The stimuli were converted into black and white 8 bit images and resized to 100 x 150 dpi. Measurement of image luminosity revealed images to be darker for male than female faces, $F(1, 356) = 163.87$, $p < .0001$. Skin colour is sexually dimorphic with males having darker skin which can lead to such luminous differences. Important for present purpose, however, there was no luminosity difference based on either the trustworthiness manipulation or the interaction between sex of face and facial trustworthiness (*p*s > .7) see also footnote 6.

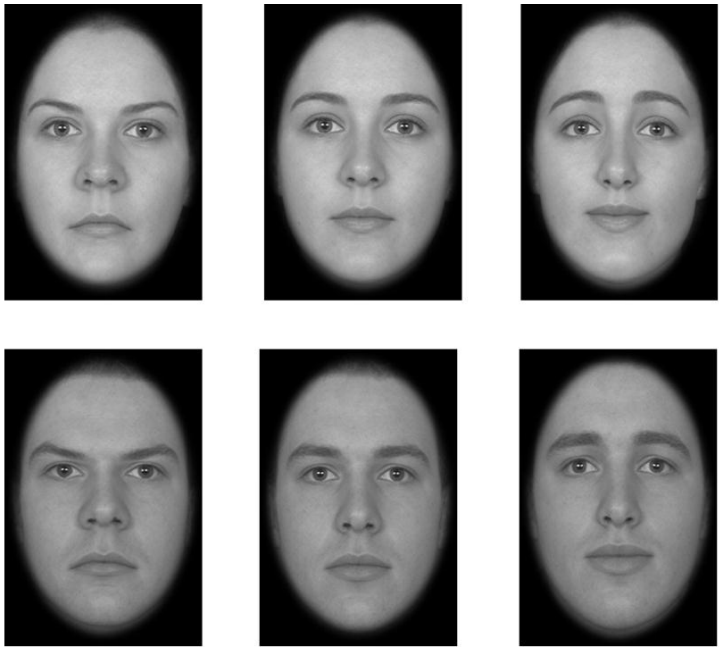

Figure 7-1. Examples of trustworthiness transformation (left: untrustworthy version (50%), mid: starting face; right: trustworthy version (50%). Note: the images are composites of 10 originally used images in the experiment

Procedure and design

Participants were instructed to respond as fast as possible while maintaining accuracy. Their task was to judge trustworthiness or gender of the images. It was stressed that trustworthiness attribution was based on their own perception. Participants responded by pressing one of two keys. In the trustworthiness discrimination task, one of the keys corresponded to trustworthy judgements while the other one corresponded to untrustworthy judgements. In the gender discrimination task, one key was assigned to female and the other key to male judgements. Key mapping was counterbalanced across participants. Half of the participants started with the trustworthiness discrimination task and the other half with the gender discrimination task. Each task was grouped in eight blocks with 45 images each. After every block, participants could take a break. The two trustworthiness versions of

the same starting identity were always presented in the two different tasks and were counterbalanced across participants. Thus each participant saw all individuals twice, once in the trustworthy and once in the untrustworthy versions of the pictures. Each trial started with a fixation cross presented on the screen for 500 ms followed by an image that stayed on the screen until a response was given but no longer than 3000 ms. Responses longer than 2000 ms were rejected as too slow. The inter-trial interval was 1500 ms.

## Data analysis

### Behavioural data

The accuracy of responses was assessed by using a predefined classification of the images based on the direction of transformation. If the images were transformed towards an untrustworthy prototype they were predefined to be untrustworthy images. If they were transformed towards a trustworthy prototype they were predefined to be trustworthy. Only reaction times for correct responses were evaluated. Before the analysis of the data the proportion of correct responses was arcsine transformed. The reaction times were log transformed and averaged for every participant. Data transformation was performed to minimise the impact of deviation from the normal distribution. For ease of interpretation the untransformed data were presented in the figures. Preliminary analysis revealed no effect of task order or key mapping for accuracy data, nor for reaction time data. Therefore, these variables were excluded from the data analysis. A mixed ANOVA with task (gender discrimination vs. trustworthiness attribution), sex of face (female vs. male) and face trustworthiness (trustworthy vs. untrustworthy) as within subject variables and participant's gender

(female vs. male) as a between subject variable was performed for the accuracy and reaction time data. Statistically significant interactions were followed up with separate ANOVAs at each level of the most theoretically relevant factor. All post-hoc analyses were Bonferroni corrected.

ERP data

The EEG recordings were examined for artifacts (amplifier blocking, scalp-muscular activity, and slow linear drift) for each participant and trial. Only trials with correct responses and without EEG artifacts were included in EEG data analysis. All signals were 0.10 – 40 Hz filtered. The stimulus-locked epoch started 200 ms prior to stimulus onset and lasted for a total duration of 1000 ms. Data were averaged separately for each condition. Visual inspection suggested that ERP waves differed between the trustworthiness levels at electrodes PO7 and PO8 in a time window 200 – 300 ms.

To analyse the effects of trustworthiness perception on early ERP components, peak amplitudes of the P1 (peak search time window 90 – 130 ms) and N170 (peak search time window 140 – 200 ms) were analysed with a mixed ANOVA. For the later component peaking at about 250 ms after stimulus onset, mean amplitudes for time windows 230 – 280 ms was used for analysis. The factors hemisphere (left vs. right) task (gender discrimination vs. trustworthiness discrimination), sex of face (female vs. male) and face trustworthiness (trustworthy vs. untrustworthy) as within subject variables and participant's gender (female vs. male) as a between subject variable were entered for all components.

## Results

Behavioural data

Accuracy

The mixed ANOVA with factors task, sex of face, trustworthiness and participant's gender revealed a main effect of task, $F(1, 30) = 187.32$, $p < .0001$, $\eta_p^2 = .86$, $r = .93$, indicating that the gender discrimination task was performed more accurately than trustworthiness attribution. A main effect of sex of face, $F(1, 30) = 37.88$, $p < .0001$, $\eta_p^2 = .56$, $r = .75$, suggested that male faces were judged more accurately than female faces. There was a significant interaction between task and gender of the participant, $F(1, 30) = 4.71$, $p = .038$, $\eta_p^2 = .14$, $r = .37$, indicating that female participants responded more accurately ($M = 68\%$) than male participants ($M = 61\%$) in the trustworthiness judgement task, but no differences between the two sexes was observed in the gender discrimination task (females: 87 %; males: 88 %). Two two-way interactions reached significant levels: task x sex of face and sex of face x face trustworthiness, $Fs(1, 30) > 32.3$, $p < .001$, $\eta_p^2 > .52$, $r > .72$. They were further qualified by a three-way interaction, task x sex of face x face trustworthiness, $F(1, 30) = 14.51$, $p = .001$, $\eta_p^2 = .33$, $r = .51$ . Post-hoc tests suggested the interaction between sex of face x face trustworthiness was only present in the trustworthiness discrimination task, $F(1, 30) = 37.70$, $p < .0001$, $\eta_p^2 = .56$, $r = .75$, but not in the gender discrimination task ($p > .05$) (see Figure 7-1). More specifically, this interaction found in the trustworthiness task was due to more accurate judgement of untrustworthy ($M = 72$ %) than trustworthy ($M = 57\%$) male faces, but the opposite

pattern for female faces: more accurate judgement for trustworthy ($M$ = 70 %) than untrustworthy ($M$ = 59 %) female faces.

Reaction times

The reaction time data mirrored the accuracy data. The ANOVA revealed a main effect of task, $F(1, 30) = 67.12$, $p < .0001$, $\eta_p^2 = .69$, $r = .83$, indicating that the gender discrimination task was performed faster (766 ms) than the trustworthiness attribution task (1024 ms). Additionally, responses for male faces were faster (885 ms) than female faces (905 ms), $F(1, 30) = 5.26$, $p = .029$, $\eta_p^2 = .15$, $r = .39$. Two two-way interactions, sex of face x task and sex of face x face trustworthiness were significant, $Fs(1, 30) > 14.98$, $ps < .001$, $\eta_p^2$s > .33, $r$s > .58. They were additionally qualified by the three-way interaction, task x sex of face x face trustworthiness, $F(1, 30) = 6.15$ $p = .019$, $\eta_p^2 = .17$, $r = .41$. Post-hoc tests revealed faster responses in the trustworthiness judgement task to untrustworthy (985 ms) than trustworthy (1072 ms) male faces, $F(1, 30) = 11.10$, $p = .008$, $r = .52$ but not female faces ($ps > .05$). No differences in trustworthiness judgement were found neither for male faces nor female faces in the gender discrimination task ($ps > .05$), see also Figure 7-2.

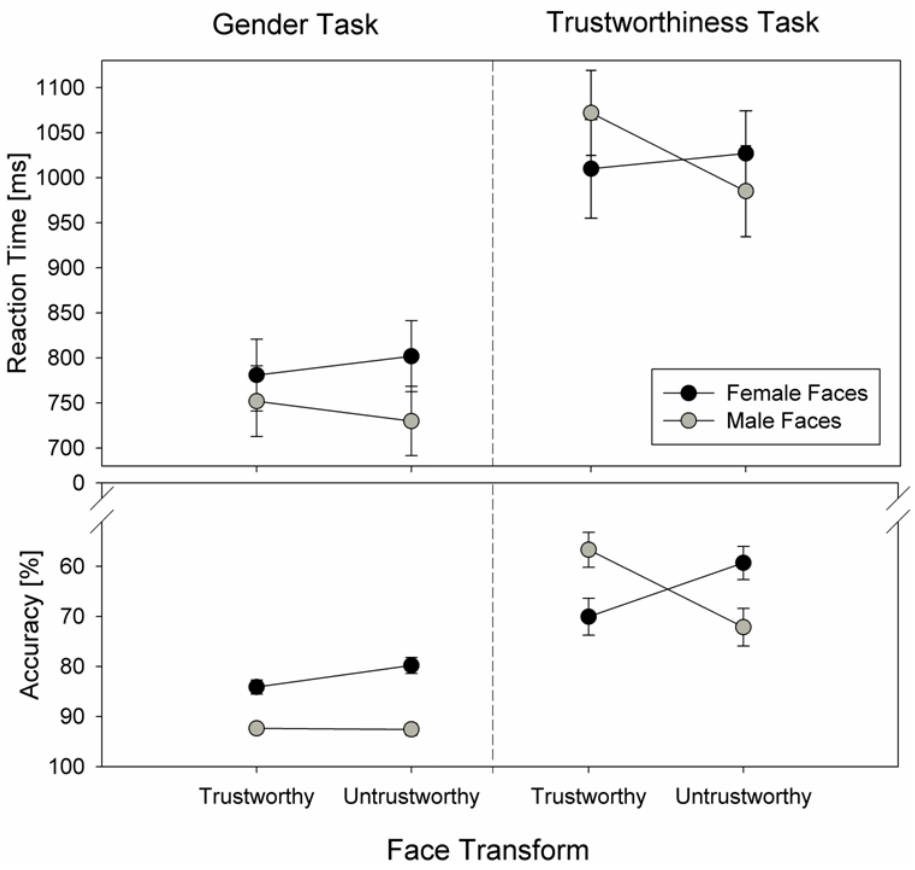


Figure 7-2. Mean reaction times (top panel) and mean proportion of correct responses (bottom panel) and corresponding SEM for the Gender Task (left panel) and the Trustworthiness Task (right panel) as a function of sex and trustworthiness of the face.

In summary, the responses in a trustworthiness judgement task were easier for trustworthy female and untrustworthy male faces as compared to untrustworthy female and trustworthy male faces, fulfilling the sex stereotyped associations (i.e. male are untrustworthy and female are trustworthy).

EEG data

Mixed ANOVAs with factors hemisphere, task, sex of face, face trustworthiness and participant's gender were conducted for all reported ERP components.

P1 amplitude

The P1 amplitude was more positive for female (10.1 μV) than male participants (5.0 μV), $F(1, 30) = 18.11$, $p < .0001$, $\eta_p^2 = .38$, $r = .61$ (see Figure 7-3). P1 amplitudes were larger over the right (9.3 μV) than left hemisphere (5.8 μV), $F(1, 30) = 11.86$, $p < .002$, $\eta_p^2 = .28$, $r = .53$. This effect was larger for female than male participants, resulting in a significant interaction between hemisphere and participant's gender, $F(1, 30) = 5.40$, $p < .027$, $\eta_p^2 = .15$, $r = .39$ . Finally, there was a significant four-way interaction hemisphere x task x sex of face x participant's gender. However, post-hoc tests in each hemisphere did not reveal significant three-way interactions task x sex of face x participant's gender, $p > .10$. No other effects were significant.

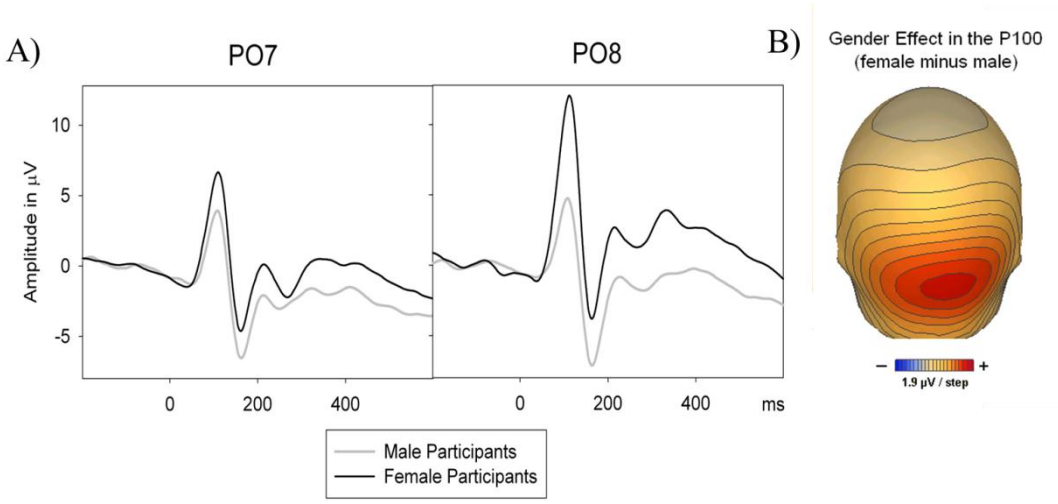


Figure 7-3. A). Participant gender differences in early visual components over posterior occipital cites PO7 (left panel) and PO8 (right panel). B) Topographic representation (Spline map) of the participant gender effect. The map depicts the difference between ERPs for female and male participants at 100 ms after stimulus onset.

N170

There was a marginally significant interaction between task and participant's gender, $F(1, 30) = 3.91$, $p = .057$, $\eta_p^2 = .12$, $r = .34$, indicating a larger effect of participant's gender in the gender discrimination task (males: $M = -8.3$, females: $M = -5.1$) than in the trustworthiness discrimination task (males: $M = -7.8$, females: $M = -5.7$). However, none of the post-hoc comparisons reached significance ($p$s > .05). Additionally, there was a trend for an interaction between hemisphere, sex of face and face trustworthiness in the N170 amplitude, $F(1, 30) = 3.33$, $p = .078$, $\eta_p^2 = .10$, $r = .32$. Separate tests for each hemisphere revealed a significant interaction between sex of face and face trustworthiness over the right hemisphere, $F(1, 30) = 7.62$, $p = .02$, $\eta_p^2 = .20$, $r = .45$, but not over the left hemisphere ($p > .10$). This interaction over the right hemisphere was due to N170 amplitudes being more negative for trustworthy female faces (- 6.9 μV) and untrustworthy male faces (- 7.1 μV) than for untrustworthy female faces (- 6.6 μV) and trustworthy male faces (- 6.6 μV) (see Figure 7-3), corresponding to the behavioural bias to perceive female faces as more trustworthy and male faces as more untrustworthy. No other effects reached significant levels (all $p$s >. 09).

EPN component (230 – 280 ms)

The ANOVA of the EPN component revealed a main effect of hemisphere, $F(1, 30) = 18.84$, $p < .0001$, $\eta_p^2 = .39$, $r = .62$, indicating that the component was more negative over the left (- 2.2 μV) than the right hemisphere (+ 0.1 μV). There was a significant three-way interaction between task, sex of face and face trustworthiness, $F(1, 30) = 4.38$, $p = .045$, $\eta_p^2 = .13$, $r = .36$. Mimicking the

behavioural results, post-hoc tests revealed that the interaction between sex of face and face trustworthiness was only present in the trustworthiness discrimination task, $F(1, 30) = 8.65$, $p = .006$, $\eta_p^2 = .22$, $r = .47$, but not the gender discrimination task, p > .10. The interaction in the trustworthiness task was due to ERP amplitudes being more negative for trustworthy female faces (- 1.8 μV) and untrustworthy male faces (- 1.5 μV) than for untrustworthy female faces (- 1.0 μV) and trustworthy male faces (- 0.8), (see Figure 7-4 and Figure 7-5.).

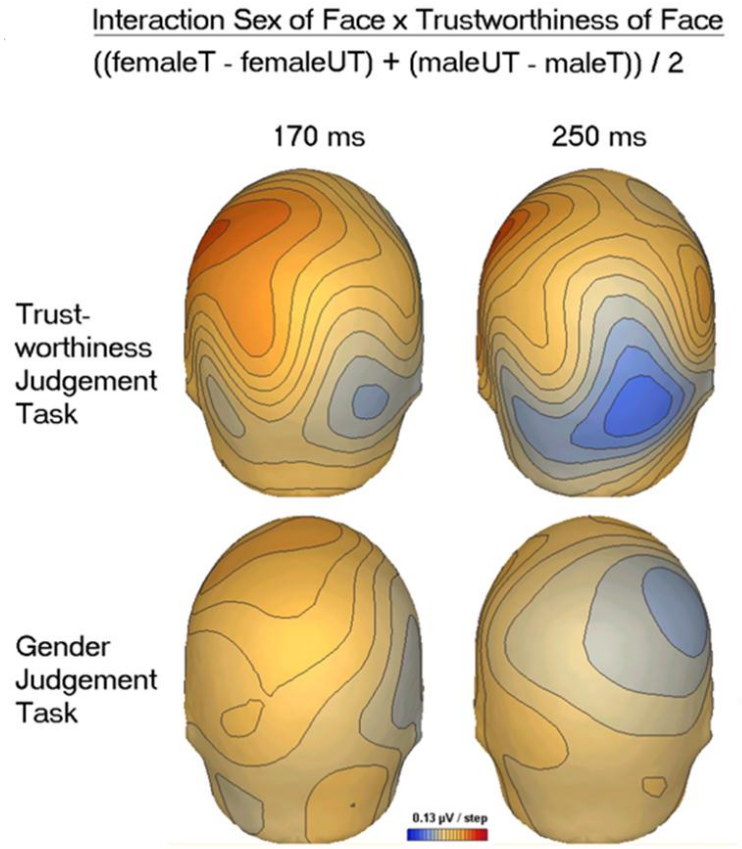


Figure 7-4. Topographic representation (spline maps) of the interaction Sex of face x Trustworthiness of face (average of (female Trustworthy minus female Untrustworthy) and (male untrustworthy minus male trustworthy), for each task separately at time points 170 ms and 250 ms after stimulus onset. T – Trustworthy; UT – Untrustworthy

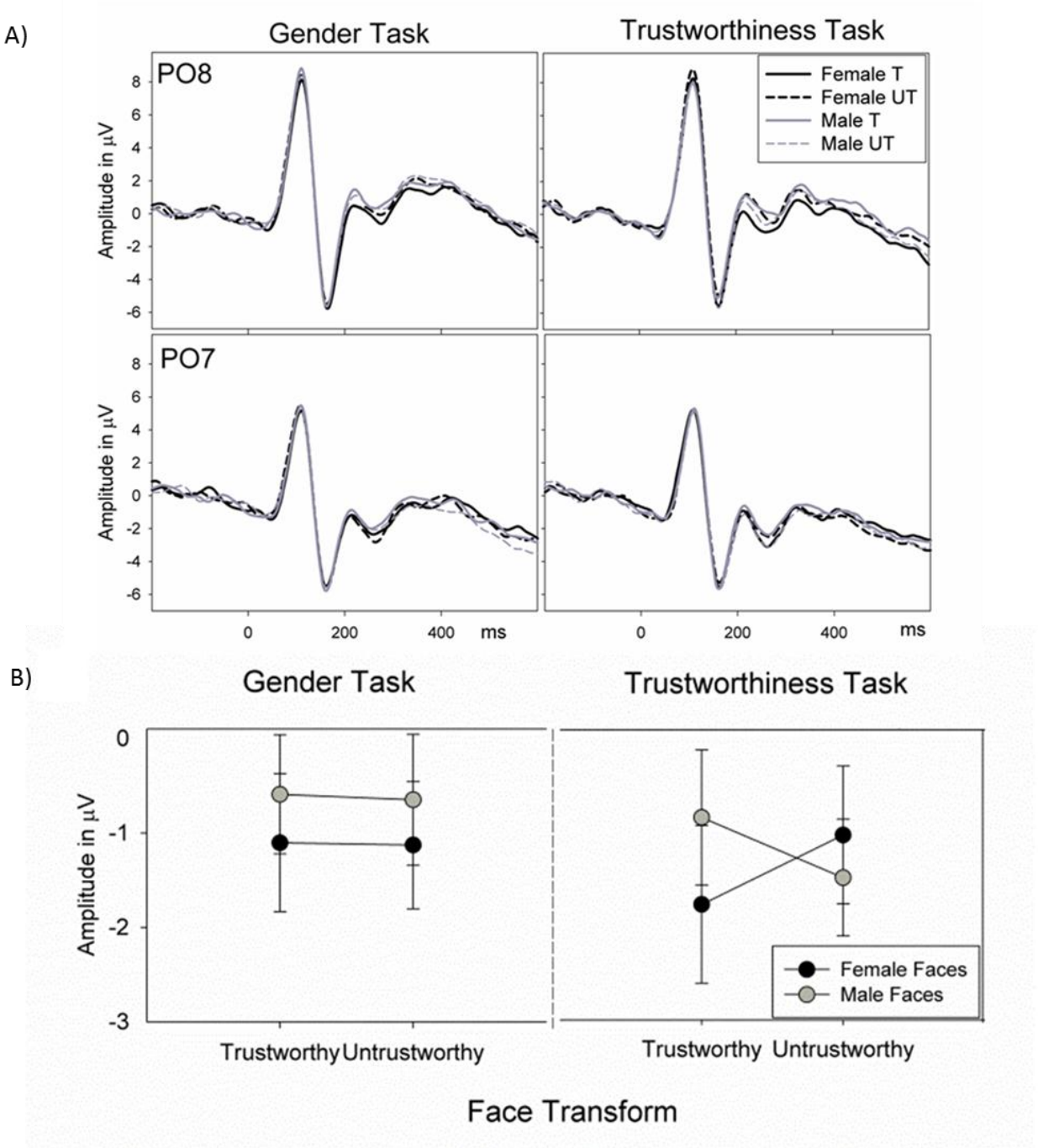


Figure 7-5. ERP modulation as a function of sex of face and trustworthiness transformation. A) Mean ERP waveforms at PO7 and PO8, shown separately for each task, with waveforms for conditions sex of face and face trustworthiness superimposed in each graph. F – Female Faces; M – Male Faces. B) Mean ERP amplitudes averaged over hemispheres, in a time window 230 to 280 ms after stimulus onset, as a function of sex and trustworthiness of the face, measured separately for each task.

To further explore the interaction between sex of face and facial trustworthiness, we tested whether the increase of the negativity in the time window 230 -250 ms correlated with the behavioural responses. The behavioural bias was calculated by averaging the accuracy levels or reaction times for the difference between faces consistent with the bias and faces inconsistent with the bias – ((female trustworthy – female untrustworthy faces) + (male untrustworthy – male trustworthy))/2. The same procedure was applied to calculate the changes in the ERP-specific bias (see also Figure 7-4). First, the increases in EPN amplitude corresponding to the behavioural bias was calculated for each hemisphere. The two ERP-specific biases for each hemisphere were averaged to produce the change of the ERP-specific bias. Each participant thus contributed to two measures of behavioural bias and one measure of ERP-specific bias (increase in EPN amplitude). The behavioural bias based on accuracy level was positively correlated with the ERP-specific bias, $r$ = .38, $p$ =. 031, N = 32. The correlation between the behavioural bias based on reaction time and the ERP-specific bias did not reached significance.

## Discussion

Here we studied the temporal dynamics of trustworthiness perception and how sex and trustworthiness of a face modulate ERPs evoked by faces. We manipulated images to look either more trustworthy or more untrustworthy and asked participants to judge their gender and trustworthiness. We expected that the spontaneous trustworthiness perception would be reflected in the ERP components, P1and N170, and posterior-occipital negativity (EPN) after 200 ms post-stimulus. We also hypothesised that due to the relationship between trustworthiness and sexually dimorphic features the trustworthiness modulation might be contingent on the sex of

the face.

From our behavioural measurements it emerged that the trustworthiness transformation affects male and female faces differently. There was a general bias to regard male faces as untrustworthy and female faces as trustworthy. Facial transformations congruent with this bias improve accuracy and speed of decisions. The bias to regard male faces as untrustworthy and female faces as trustworthy can also be described reciprocally as a tendency to see untrustworthy faces as male, whereas trustworthy faces are seen as female. Congruent transformations of trustworthiness improved gender discrimination; enhancing untrustworthiness makes the faces look more male and conversely enhancing trustworthiness makes the faces more female. This evidence further supports the relationship between sex and trustworthiness. Sex-typical features bias the perception of trustworthiness, for instance increasing the masculinity of faces decreases the perception of trustworthiness (Buckingham, et al., 2006; Oosterhof & Todorov, 2008; Perrett, et al., 1998). Furthermore, as argued in the introduction, the structural features conveying trustworthiness are suggested to be sexually dimorphic (Enlow & Hans, 1996; Stirrat and Perrett, 2010; Weston, et al., 2007).

Our EEG data suggested that trustworthiness did not affect the P1component. However, the P1 was modulated by participant's gender, with larger P1 amplitudes for female than male participants, especially over the right hemisphere. The gender specificity of this effect excludes the possibility that low-level stimulus differences account for it, as the same stimulus material was used for male and female participants. Further studies are required to explore possible gender differences in perceptual experiments using a wider variety of face and non-face stimuli.

The behavioural bias of improved performance for untrustworthy male faces and trustworthy female faces for the trustworthiness discrimination task was reflected in the amplitude of two later ERP components, the N170 and a negative deflection from 230 to 280 ms, with more negative amplitudes for faces congruent with the bias (i.e. trustworthy female and untrustworthy male faces) than faces not congruent with the bias. The interaction between trustworthiness and sex of face found for the amplitude of N170 was only present over the right hemisphere. The results suggest a rapid and spontaneous processing of trustworthiness. Right-lateralised face processing is consistent with numerous fMRI (e.g. Kanwisher, McDermott, & Chun, 1997; Sergent, Ohta, & Macdonald, 1992) and ERP studies (e.g. Rossion, et al., 1999, Rossion, Joyce, Cottrell, & Tarr, 2003; Bentin et al., 1996; Bötzel, Schulze, & Stodieck, 1995). Additionally, a stronger activation within the amygdala and the superior temporal sulcus (STS) in the right hemisphere during automatic perception of trustworthiness has been reported (Engel, et al., 2007; Winston et al., 2000). Our result also fit with recent findings of a larger N170 for sex typical than sex atypical faces (Freeman, et al., 2010). Since trustworthy transformations boost the femininity of faces and untrustworthy transformations increase the masculinity of faces, the modulation of N170 we report may reflect the same process. Taken together, our N170 findings and Freeman et al.'s (2010) results suggest that the social categorization of faces occurs at an early stage of processing or perhaps during the structural encoding of the face. The results question the Bruce and Young's face perception model (Bruce & Young, 1986) indicating that there might be a cross talk between different types of social information, namely between gender and emotion (or trustworthiness). However, as effects in early visual components can often be attributed to differences in low level stimulus features (e.g., stimulus contrast,

luminance, colour, etc.) our N170 results should be considered with caution. Nevertheless, given that the effects found in the N170 amplitude were not present in the earlier P1 analysis, we see this explanation as unlikely.

Importantly, the amplitude of a later (230 – 280 ms) negative deflection (EPN) was also contingent on both the sex and trustworthiness of the face. The EPN was more negative for trustworthy than untrustworthy female faces yet showed the opposite pattern for male faces with greater negativity to untrustworthy than to trustworthy male faces. This effect was only present for trustworthiness but not gender judgements. This task-specificity of the effect is important as it rules out differences in stimulus material producing this effect, as the same stimulus material was used for both tasks. Recently, an investigation exploring political elections reported an increased desynchronisation within the lower alpha band over neighbouring parieto-occipital areas for candidates judged to be trustworthy (Vecchiato, et al., 2010), thus arguing that posterior occipital regions are implicated in trustworthiness perception.

Trustworthiness attribution has an important role in the assessment of others – if they are friends or foes, approachable or unapproachable. We have reasoned that being able to make such judgements quickly is adaptive both for avoiding untrustworthy individuals but also for remembering trustworthy individuals for future cooperation. We interpret the negativity recorded at latencies 230 – 280 ms during explicit trustworthiness judgements to reflect an increased depth of processing of important faces as a result of amygdala back projections to the cortex. The amygdala feedback would reinforce the structural coding of these faces for more effective future recollection.

Salient stimuli such as emotional faces have been noted to increase the amplitude of a negative component at latencies of 200 ms (Martens, et al., 2010; Sato, et al., 2001; Schupp, et al., 2003; Williams, et al., 2006). Additionally, arousing stimuli for example, mutilation and erotic scenes modulate the amplitude of EPN (Schupp, et al., 2004). The increase in negativity for salient stimuli is often interpreted as a result of enhanced perceptual awareness of the visual stimuli (Sato, et al., 2001) and attributed to re-entrant projections from the amygdala to the cortex (Sato, et al., 2001; Schupp, et al., 2003).

Male untrustworthy faces were the most efficiently processed category. Since such males can be deemed to be the most dangerous category (looking more angry and being more capable of exploiting trust), one might expect that amygdala back projections, as part of the vigilance system, to have the largest effect on this category. On the other hand, overall, female faces were perceived as more trustworthy than male faces. We speculate that trustworthy female faces are important to process deeply in order to enhance memory for their identity. These are individuals with whom the observer is most likely to have beneficial future interactions. Our findings are consistent with other studies reporting an increase in negativity 250 ms post-stimulus accompanying deeper processing of important stimuli (e.g. Bentin & Deouell, 2000; Tanaka, Curran, Porterfield, & Collins, 2006; Schweinberger, Huddy, & Burton, 2004). Such processing potentially reflects a recognition bias induced by the participants' associations based on stereotypes. Collectively, it can be speculated that male untrustworthy and female trustworthy faces are processed deeper. This deeper processing was also reflected in the positive relationship between the increased negativity of the EPN (230-280 ms) and the increased accuracy for those stimuli.

## Conclusion

The reported study found that P1amplitude was larger for female participants, particularly over the right hemisphere. Facial features related to trustworthiness affected the amplitude of N170 over the right hemisphere, thus suggesting a rapid processing of trustworthiness. The discrimination of trustworthiness characteristics continued to affect scalp-recorded negativity 230 – 280 ms. For both components – N170 and EPN – an amplitude increase (more negative components) was observed for both female trustworthy and male untrustworthy faces. We speculate that the negativity in the ERP, 230 – 280 ms post-stimulus during explicit judgements of trustworthiness, is driven by limbo-cortical processes monitoring stimulus salience. Furthermore, the different modulation of the face-evoked ERP components based on sex of the face reinforces the importance of gender when investigating trustworthiness perception.

[6] Data was analysed with a subset of trustworthy (110) and untrustworthy (110) images that did not differ in luminance across experimental conditions (all *p*s > .05). Analysis of the data from this subset of stimuli replicated all important aspects of our ERP findings and is reported below. P1: All results were replicated. N170: Again, all results were replicated. Moreover, the previously reported trend for an interaction between hemisphere, sex of face and face trustworthiness in the N170 amplitude now reached significant level, $F(1, 30) = 4.39$, $p = .045$, $\eta_p^2 = .13$, $r = .36$.

The ANOVA of the EPN component again overall confirmed of the results reported in the main section. There was a two-way interaction sex of face x face trustworthiness, $F(1, 30) = 5.51$, $p = .026$, $\eta_p^2 = .16$, $r = .39$, indicating more negative ERP amplitudes for trustworthy female faces (- 1.5 μV) and untrustworthy male faces (- 1.1 μV) than for untrustworthy female faces (- 1.1 μV) and trustworthy male faces (- 0.6). This interaction tended to be task-specific, $F(1, 30) = 4.38$, $p = .18$, $\eta_p^2 = .06$, $r = .36$, only being present in the trustworthiness judgement task, $F(1, 30) = 6.65$, $p = .014$, $\eta_p^2 = .18$, $r = .43$, but not the gender discrimination task, $F(1, 30) = 0.10$, $p = .75$, $\eta_p^2 = .003$.

# Chapter 8

*General Discussion*

In this thesis, I examined how several facial cues: head posture, gaze direction and skin colour, effect trustworthiness and cooperativeness perception. These facial characteristics can guide choices that maximise the benefits or reduce the costs of cooperative acts. The cues advertise the qualities of the counterpart, and thus, the observer can choose partners with positive intentions (indicated by a positive emotion/subordination or direct gaze) and good health (yellowish skin colour) and avoid partners who can inflict cost on the individual (dominant individuals who can exploit with impunity; individuals disinterested in cooperation, or unhealthy individuals). These considerations are especially important when taking into account the mechanisms for evolution of cooperation and in particular, the mechanism of direct reciprocation (Trivers, 1971): cooperative acts are returned by the same two individuals.

In this concluding chapter, the findings of the experimental chapters will be discussed mainly within the framework of Trivers' (1971) theory for evolution of cooperation as a reciprocated social exchange. Face resemblance cues were not manipulated in the experimental chapters and as a result kin selection theory (Hamilton, 1964a, 1964b) will not be discussed in relation to the findings. Furthermore, the experimental chapters evaluated desired counterpart's characteristics from the perceiver's perspective, reputation building as a mechanism for indirect reciprocation and costly signalling theory of cooperation (Gintis et al., 2001) will also not be discussed. Additionally, some remarks on the psychological adaptations – 'overgeneralization' of attributes and 'negative bias' – will be provided. First, a brief summary of the results will be presented and then each of the cues – head posture; gaze direction and skin colour will be separately discussed.

**Summary of experimental results**

In the first experimental chapters investigating the effect of head posture on cooperativeness perception, I have demonstrated that a subtle downward tilt of the head is perceived as more cooperative. When participants are given the opportunity to freely adjust head tilt to make the head models look most cooperative, they tilt the head models slightly down (less than 3°). This head tilt can be interpreted as a display of willingness not to dominate the social interaction. By blurring out the eye region, some evidence that the postural effects on cooperation is primarily due to head position rather than gaze direction was provided. Additionally, characteristics of the perceiver and the counterpart had impact on the importance of the head tilt. In chapter 4, I showed that the downward head tilt was increased if the faces were perceived as unfriendly or hostile, particularly by participants who judged themselves to be subordinate. In chapter 5, when investigating the effects of gaze direction, the results revealed that gaze looking eye to eye or gaze looking slightly down were perceived as cooperative, suggesting that direct gaze is perceived to communicate approach behaviour and positive behavioural intentions. The use of the 3D images in these experimental chapters enabled me to address head tilt as a cue to cooperativeness from a new perspective and to overcome some of the disadvantages of 2D photography. Yet, 3D stimuli also introduced some limitations that could be further explored in future studies.

Cues to health were also shown to be crucial for the choice of social partners: yellow skin colour increased ratings of trustworthiness perception (chapter 6). As judgements about who you trust and cooperate with are vital for social interactions, the last experimental chapter evaluated the temporal dynamics of trustworthiness

perception. The results indicated that neurophysiological components coding face processing (within 170 ms) are modulated by the perceived facial trustworthiness, providing further evidence for the automatic processing of facial trustworthiness. Additionally, facial trustworthiness continued to modulate a negative component responding to stimulus salience (within 230 – 280 ms post stimulus).

Employing computer graphics to manipulate faces along shape and colour axes provided several advantages over alternative methods: it allowed for a direct comparison of ratings within the same facial identity, thus controlling for potential artifacts associated with differences in shape or colour. Moreover, changing the colour dimension (in chapter 5) towards known optimal settings has not been done before. Admittedly, the procedure may introduce artifacts that can influence the investigated judgements. Although, this possibility has yet to be tested, I believe it is unlikely. It is not obvious that extraneous cues like yellower facial hair or increased contrast between the lips and the upper facial part, for example, will affect the social judgements in the same direction as the current results. Furthermore, increasing the yellowness in skin colour should increase negative evaluation. Indeed, lighter images (i.e. white skin colour) are shown to be more positively evaluated (e.g. Mandler, Nakamura, & Van Zandt, 1987).

Additionally, it is notable that the effect sizes of the influence of these characteristics were moderate and in some instances large (i.e. yellow skin colour accounted for approximately 11 % of the variance in the social perception of attractiveness and trustworthiness, while head tilt explained between 16% and 23% of the variance in attributing cooperativeness). This effect sizes might not seem substantial, yet it is impressive how a single characteristic like skin colour or head

posture influences choice of a mate or a cooperative partner, decisions assumed to be rational and deliberate. Furthermore, these facial characteristics can still have an impact on social perception and thus effect the interaction in which an individual is involved. It is also notable, that in the reported studies only a limited number of characteristics were manipulated and in real world situations, several factors might vary thus decreasing the importance of the investigated facial aspects. Future studies can test the validity of the cues found here (head posture; gaze direction and skin colour) in real life situations and provide information about the importance of these cues as well as evidence for the 'kernel of truth' hypothesis.

**Cues to trust and cooperation and theories of cooperation**

Head posture

Chapter 3 argued that the impression of looking more cooperative when the head was tilted slightly down might be a result of an association with postural cues to status. For cooperation, a display of lowering the head may confirm that an individual is not a threat. Alternatively, it is possible that tilting the head down made the facial expression appear happier, hence hostile looking faces needed to be tilted further down in order to achieve the same level of friendliness and cooperativeness display. Both of these interpretations are examples of 'overgeneralization',, a principle discussed in the introductory chapter (Zebrowitz & Montepare, 2006; van Vugt & van Lange, 2006). The head tilt does not change the emotional expression, yet, it is possible that perception of the emotion is altered by the head tilt. The rotation of the head can lead to the mouth corners being perceived as curved up – a configuration of

the mouth that is associated with a smile. Thus, this subtle perceptual resemblance to happiness may impact positively on the attribution of cooperation.

The head tilt is also associated with displays of dominance (Mignault & Chiodure, 2006, Hall et al., 2006). Seeking a low dominant individual as a partner for a cooperative venture will reduce the chance of exploitation since this partner will not be as able to implement hostile intentions. This interpretation is an example of the 'overgeneralization' and the 'negative bias' adaptation (van Vugt & van Lange, 2006). First, negative behaviour – aggression (e.g. Carré & McCormick, 2008); cheating (Haselhuhn & Wong, 2012); exploitation (Stirrat & Perrett, 2010); dishonesty (Perrett et al., 1998) – is associated with masculine face shape and increased levels of testosterone, and hence increased perceived dominance. Second, these negative perceptions are generalised to any dominant looking individual. Third, any subtle cues to dominance are overestimated, in order to avoid the potential cost of choosing the wrong partner. Additionally, face variations towards the negative end of the trustworthiness spectrum are more easily detected (Todorov, 2008) and similar effects could be expected for detection of uncooperativeness. As a result, a display of subordination or willingness not to dominate the interaction increases the perceived cooperation.

Further support that the lower head is used as a cue of counterpart's positive intentions is provided from the findings that the effect of head posture is influenced both by participants' own dominance and the perceived hostility of the counterpart. Male faces and faces that were perceived as more threatening were rotated downwards more. These findings are consistent with the general bias that male individuals are perceived as less trustworthy and less cooperative than female faces.

As summarised in chapter 2, this bias is also evident in the facial shape affecting trustworthiness perception. Prototypical male faces are perceived as less cooperative (Perrett et al., 1998) and less trustworthy (Oosterhof & Todorov, 2008, Buckingham et al., 2006) than prototypical female faces. Furthermore, social stereotypes dictate that anger displays are more appropriate for men and smiling is a requisite for women (Hess, Adams, & Kleck, 2005). Additionally, women are perceived as more affiliative, while men - as more dominant; and these two dimensions as discussed in the introductory chapter influence trustworthiness perception. These differences in perception can account for some of the experimental findings. The characteristics were employed to define the faces as hostile were dominance and emotional expression, thus male faces might have been perceived as more unfriendly and therefore rotated further down.

Further supporting evidence that the head tilt increases the perception of cooperativeness as a result of an association with decreased willingness to exploit are provided by the results that the importance of head tilt is dependent on the self-perceived dominance of the individual. The display of willingness not to dominate the interaction is less important for dominant individuals as the cost of underestimating the partners' power characteristics is lower (i.e. an uncooperative partner is less likely to be able to free ride without punishment) than for subordinate individuals (Watkins et al., Stirrat & Perrett, 2010).

Collectively, these findings suggest that the head tilt is used as a cue communicating the intentions of the potential partner. A desired partner is an individual who demonstrates a willingness not to dominate the interaction or a positive attitude towards the perceiver. Such individuals are less likely to inflict any

cost to the cooperator and are more likely to reciprocate, supporting the idea that cues to trustworthiness and cooperation are guided by assessments of the partners that help to maximise the benefits and to reduce the cost of the cooperative act.

Gaze direction

Similarly to positive emotional expression, it can be speculated that direct gaze and gaze 3° down are interpreted as a communicative sign for positive attitude and are associated with approach behaviour. The reciprocated gaze leads to a mutual gaze. Thus, it will be easier for an individual to assess the real intentions of another person if the counterpart is looking at the perceiver. Furthermore, direct gaze can be interpreted as a demonstration of social engagement and intention to commit to a mutual cooperative act. Therefore, faces with direct gaze are perceived as more cooperative than faces that do not look into the regions of the partners face conveying communicative information (eyes or mouth region). Similarly to eye to eye contact, looking 3° down is perceived as cooperative. Looking 3° down is equivalent to looking at the mouth region of a person. This gaze angle may not only be perceived as looking at the person, but it can also facilitate emotional perception and speech recognition (Caldara et al., 2005). Various cues associated with displays of emotion are effecting perception of trustworthiness and cooperation (e.g. Oosterfoh & Todorov, 2008; Kumhuber et al., 2006).

To sum up, the impact of direct gaze and gaze looking 3° down suggest that the qualities and the motives of the partner are assessed before engaging into cooperative endeavour. Having a positive attitude towards a potential partner is indicated by reciprocated gaze and implies that the individual is willing to be involved

in a cooperative act. Mutual regard can hint that the chances of reciprocation are larger than if an individual demonstrates no interest (averted gaze) or limited interest (proximate but still averted gaze) in the cooperative act.

Healthy skin colour

As argued in chapter 6, healthy skin colour, might be a perceptual cue guiding social interactions and the choice of partners. In chapter 6, the manipulated skin colour was empirically derived as the optimal amount of colour resulting from fruit and vegetables consumption (Stepehen et al., 2009; Whitehead et al, 2012). Carotenoids are yellow-red organic pigments which are abundant in fruit and vegetables. Thus, it can be argued that the skin colour manipulation represents changes of colour associated with carotenoid levels deposited in the skin. Throughout, the animal kingdom, bright carotenoid colouration is sexually selected (Lozano, 1994) and indicates current health condition (Vinkler, & Albrecht, 2010), this cartenoid colour in human skin might be used as an indicator of current health status in humans (Stephen et al, 2012). Carotenoid coloration is argued to be an honest indicator of quality due to a necessary trade-off between carotenoid used as antioxidants and those displayed in ornamentation (Dowling & Simmons, 2009). If healthy skin colour is an honest signal of current health, then healthy skin colour indicates several important aspects for social interactions: 1) the individual is healthy and engaging in social interaction will not infect other individuals; 2) it is possible that this individual possesses abundant resources that can be shared; and 3) it is possible that the healthy individual will live longer, leading to more opportunities for cooperation. All three aspects suggest that cues assisting the selection of a partner allow the individuals to maximise the benefits from the cooperative interactions. The last two aspects, in

particular, provide evidence that cues influencing cooperation and trust decisions are affected by considerations of direct reciprocation (Trivers, 1971). These two aspects – long life duration and availability of resources - are perquisites for the evolution of direct reciprocation (Trivers, 1971).

The first point – avoidance of infection – is worth discussing in relation to mechanism associated with the 'behavioural immune system' (Schaller & Park, 2011). As briefly outlined in the experimental chapter, the 'behavioural immune system' is a psychological mechanism protecting the individual by inhibiting or avoiding contact with pathogen (Schaller & Park, 2011). More importantly, it can influence the choice of people, an individual interacts with and thus, the selection of potential partners. Similar to the choice of a social partner, the 'behavioural immune system' is a subject to a negative bias. The cost of misperceiving an infectious person as healthy is higher than the cost of erroneously perceiving a healthy person as infectious (Schaller, 2011). As a result, heuristic cues used as an indicator of health state will be exaggerated and cues to diseases will be over-perceived. It is suggested that the 'behavioural immune system' is sensitive to a broad range of superficial cues implying non-normative physical appearance. Perceptual mechanisms employed by this system will undoubtfully impact choice of social partners: unhealthy looking partners will be distinct from the normal physical appearance and will be avoided. The perception of an unhealthy individual will also be prejudiced. Conversely, partners with healthy skin are closer to the normal or even exaggerated in the positive direction 'super normal' and thus are going to be preferred. A similar effect of exaggerated positive characteristics compared to the average (norm) can be seen for

attractiveness: attractive individuals are preferred as social and mate partners. Indeed healthy colour increases attractiveness perception (Whitehead et al., 2012).

Overall, using cues to health in order to select a partner provide further evidence that the choice of social exchange counterparts is based on decision processes facilitating the increase of benefits and the reduction of costs. Such considerations conform to the theory of reciprocated social exchange (Trivers, 1971) as an evolutionary mechanism for evolution of cooperation.

Automaticity of trustworthiness perception.

The modulation of trustworthiness transformation on early visual evoked potentials (170 – 250 ms) suggests a spontaneous encoding of this trait attribution. Given the vital role of trustworthiness assessment and its guiding role in approaching and avoiding behaviour, the automatic assessment of this trait is very important. Individuals with brain injuries affecting social judgments are impaired in their social life and often very vulnerable (e.g. Adolphs, 1998; Hall et al, 2004; Quadflieg, Todorov, Laguesse, &Rossion, in press). Facial features related to trustworthiness affected the amplitude of N170 (face specific component) and continued to affect scalp-recorded negativity 230 – 280 ms post stimulus. For both components, the amplitude increase (more negative components) was observed for both female trustworthy and male untrustworthy faces. These results are concordant with the interpretation that trustworthiness features and features conveying sex of face are not independent as outlined in the introductory chapter summarizing the facial characteristics impacting on trust and cooperation. Furthermore, the trustworthiness modulation of N170 suggests a rapid processing of this trait assessment. As argued in

chapter 7, modulation of this face selective component, sensitive to the structural encoding of the face, suggests rapid stimulus driven evaluation rather than a top down assessment of trustworthiness.

In the experimental chapter, it was speculated that the increase of negativity of the event related potential 230 – 280 ms post-stimulus during explicit judgements of trustworthiness, was driven by limbic-cortical processes monitoring stimulus salience. Thus, the female trustworthy faces will be remembered while male untrustworthy faces will be avoided. This interpretation further supports the idea that the attributions of trustworthiness and thus cooperation are affected by processes and choices assisting decisions to increase benefits and to avoid incurring costs during the cooperative acts

**Limitations and Future directions**

The limitations of the present studies provide valuable opportunities for future research. The controlled experimental designs of the conducted studies can be criticised for lacking the elaborated nature of actual social interactions. Future studies can explore the validity of facial cues employed to judge trustworthiness and cooperation in natural cooperative endeavours and if people display them in everyday situations. Investigating whether head tilt is in fact a signal that is displayed to indicate willingness to engage in cooperative acts and if mutual gaze enhances cooperation are some directions for future experiments. This work, for example, may examine if people lower their heads when asked to display cooperation. Similarly, when participants are playing economic games – Prisoner's Dilemma, do people raise their head in moments of defection and non-cooperation. Such experiments will

complement studies suggesting that some facial cues used as a heuristic to judge traits impacting on trust and cooperation are valid (Stirrat & Perrett, 2010; Wilson & Eckel, 2006); or are over-perceived as an indicator of a trait but in reality are not necessary displayed (Hall et al., 2006).

Another limitation can be that the coherent perception of a person is formed from numerous sources rather than based solely on facial appearance. In order to understand the mechanism for evolution of cooperation, a more elaborate picture of an individual needs to be provided. Recent studies suggest that information from the body and the face offers a more coherent perception of a person (Aviezer, Trope, & Todorov, 2012; Willis, Palermo, & Burke, 2011). Further evidence that the perception of an individual is more complex is provided by a study reporting enhanced memory for individuals that were perceived as more trustworthy but had bad traits – i.e. trustworthy looking cheaters (Suzuki & Suga, 2010). Elaborating on how cues from different sources – face, voice, behaviour etc. – are integrated in person perception is an important future perspective. Faces in real life do not just appear instantaneously, but people have the opportunity to interact with each other and gain information from different sources.

In order to fully understand the decisions guiding the choice of cooperative partners, information about the brain processes needs to be further explored. The network involved in the formation of snap judgements – face perception areas within the fusiform gyrus; amygdala and insula (e.g. Adolphs, 2002; Winston, et al, 2002; Hall et al, 2010) is extended to include areas within the prefrontal cortex and temporal parietal junction (e.g. Baron, Gobbini, Engell, & Todorov, 2011; Cloutier, Gabrieli, O'Young, & Ambady, 2011; Ma et al., 2011) in order to accommodate for situations

when information about a person is updated. In the case of trustworthiness perception, patients with damage to the dorsomedial prefrontal cortex are impaired in learning affective trait associations but patients with hippocampal damage were able to learn these relations (Todorov & Olson, 2008). In a subsequent experiment (Baron et al., 2011), normal participants had to judge the trustworthiness of a face and then in a learning session they were provided with positive, negative description or no description of the faces. During the learning phase, the dorsomedial prefrontal cortex was activated. The strength of the "first impression" modulated the integration of the subsequently provided information whereby participants who were strongly affected by the "first impression of the face" were less influenced by the subsequent information.

Interestingly, during processing of incongruent information, none of the studies report activation in Anterior Cingulate Cortex, a structure involved in conflict detection. Typical tasks recruiting the anterior cingulated cortex are the Stroop task, Flanker task and Go/Nogo task in which competing information is present (for a review, see Botvinick, Cohen, & Carter, 2004). Additionally, when violation of expectations is present, for example in a gambling task, Anterior Cingulate Cortex is activated more in trials when participants were expecting to win but in fact they lost (Polezzi et al., 2008). Future studies can address the question of building a coherent picture of a person when conflicting information is presented by employing neurophysiological methods. The higher temporal resolution of this technique can also provide further information about the dynamics of the process. An event related potential, N200, has been identified to index inconsistency detection and is reported to originate from Anterior Cingulate Cortex (Botvinick et al., 2004). N200 is a

negative component, peaking at central sites around 200ms post-stimulus. It reflects a response to conflict detection and is increased in amplitude for inconsistent trails. As such, N200 is a perfect candidate to evaluate updating of inconsistent information in perception of cooperativeness.

## Conclusion

In summary, the work reported here demonstrates some novel cues affecting facial appearance that impact on trust and cooperation. Cues signalling positive intentions and good health are used to guide choices of cooperative partners, thus increasing benefits and reducing the cost of the cooperative act. These cues advertise the motives and intentions of the counterpart and thus inform the choice of a partner who is more likely to reciprocate in social exchange. Understanding the mechanism that are used in order to select social partner and why they have evolved as such adaptations is important as it gives the opportunities to 1) enhance personal social success; 2) avoid unfair biases based on instant judgements and 3) to promote such pro-social behaviour.

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# Appendix A. Questionnaire measuring self-assessed dominance

Please, use the 7 point scale to indicate how much do you agree with the following statements:

1) **If you were engaged in a physical fight with a same-sex peer, you will probably win!**

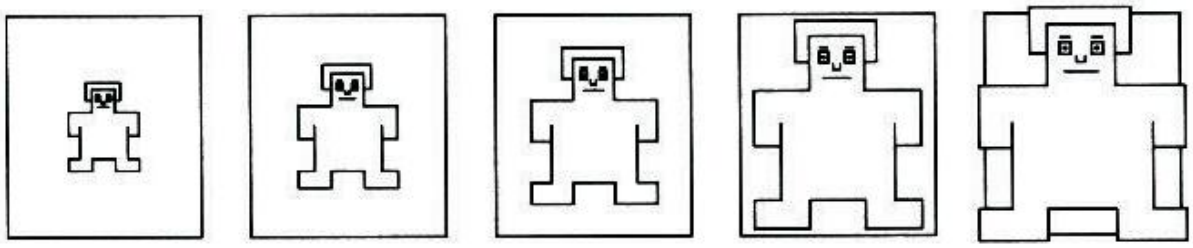
| strongly disagree | | | | | | strongly agree |
|---|---|---|---|---|---|---|
| 1 ○ | 2 ○ | 3 ○ | 4 ○ | 5 ○ | 6 ○ | 7 ○ |

2) A **SOCIALLY DOMINANT** person tells other people what to do, is respected, influential and often a leader; while submissive people are not influential or assertive and are usually directed by others!

Based on the statement above, do you consider yourself to be:

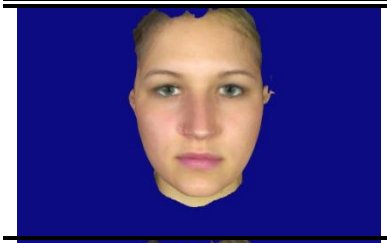
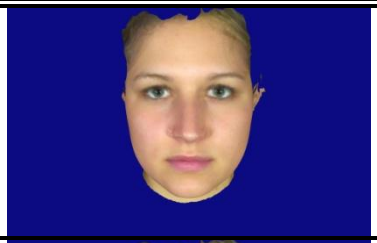
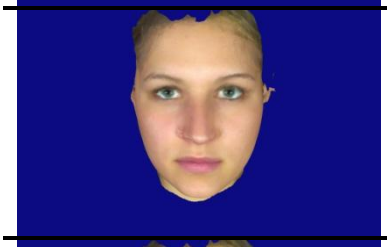
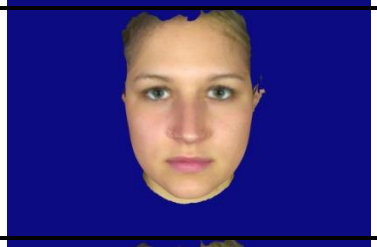
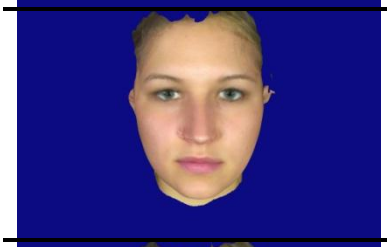
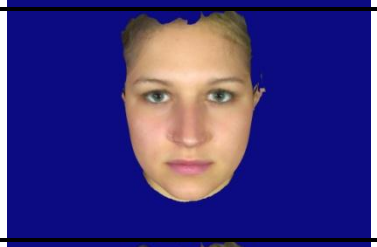
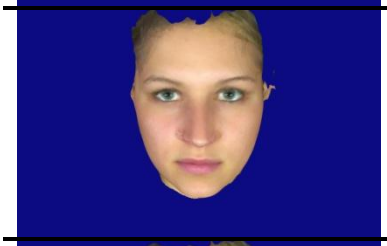
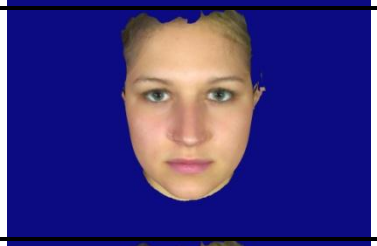
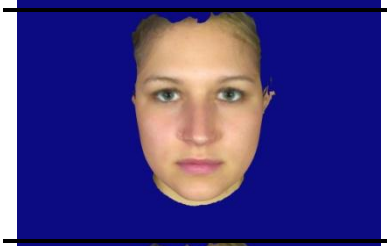
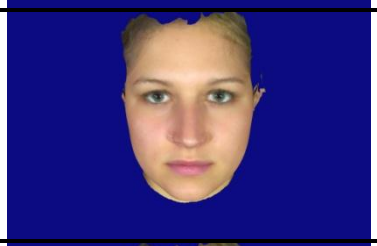
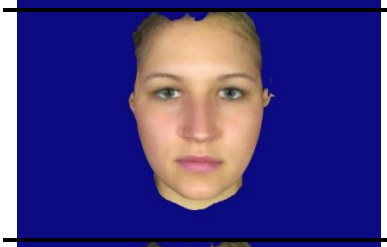
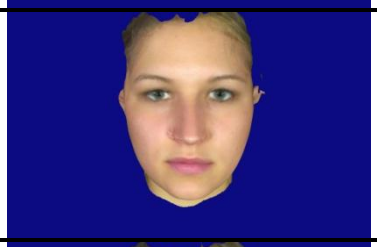
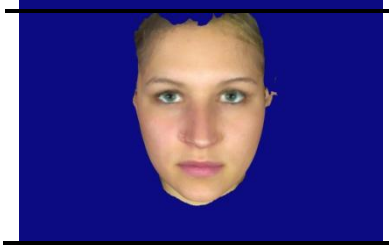
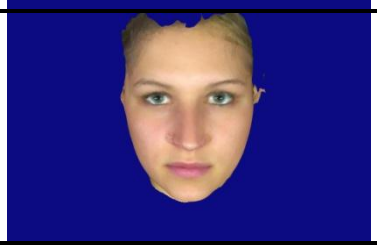
| highly submissive | | | | | | highly dominant |
|---|---|---|---|---|---|---|
| 1 ○ | 2 ○ | 3 ○ | 4 ○ | 5 ○ | 6 ○ | 7 ○ |

3) Please indicate which figure corresponds to your self-assessed physical dominance:



○ ○ ○ ○

# Appendix B. Experimental conditions in chapter 5

| | |
|---|---|
|   | **Left image**: head posture - level; gaze direction - 6° down<br>**Right image**: head posture - level; gaze direction - 0° (looking eye to eye) |
|   | **Left image**: head posture - level, gaze direction - up 6°<br>**Right image**: head posture level, gaze direction - 0° (looking eye to eye) |
|   | **Left image**: head posture -3° down ; gaze direction - down 9°<br>**Right image**: head posture - 3° down ; gaze direction 3°down (looking to the mouth) |
|   | **Left image:** head posture -3° down ; gaze direction - 3° up<br>**Right image**: head posture - 3° down ; gaze direction 3°down (looking to the mouth) |
|   | **Left image**: head posture - level; gaze direction - 0° (looking eye to eye),<br>**Right image**: head posture 3° down; gaze direction - 3° down (looking to the mouth region) |
|   | **Left image**: head posture level; gaze direction 6° down, **Right image**: head posture - 3° down; gaze direction - 9° down |
|   | **Left image**: head posture - level; gaze direction - 6° up,<br>**Right image**: head posture - 3° down; gaze direction - 3° up. |

# Appendix C. Ethical approvals

1. PS5970
2. PS6035
3. PS6926
4. PS7430
5. PS9129
6. PS6305

University of St Andrews

University Teaching and Research Ethics Committee
School of Psychology

5 November 2009

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS5970 |
| **Project Title:** | Head orientation and the impression of trustworthiness |
| **Researchers Name(s):** | Milena Dzhelyova |
| **Supervisor(s):** | Professor David Perrett |

Thank you for submitting your application which was considered at the School Ethics Committee meeting on the 4th November 2009. The following documents were reviewed:

| | |
|---|---|
| 1. Ethical Application Form | 04/11/2009 |
| 2. Participant Information Sheet | 04/11/2009 |
| 3. Consent Form | 04/11/2009 |
| 4. Debriefing Form | 04/11/2009 |
| 5. Recruitment Letter | 04/11/2009 |
| 6. Questionnaires | 04/11/2009 |

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Convenor of the School Ethics Committee OR Convener of UTREC

Ccs Prof. Dave Perrett (Supervisor)
School Ethics Committee

15 December 2010

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS5970 (Amendment) |
| **Project Title:** | Head Orientation and the Perception of Trustworthiness |
| **Researchers Name(s):** | Milena Dzhelyova |
| **Supervisor(s):** | Professor David Perrett |

Thank you for submitting your application which was considered at the Psychology School Ethics Committee meeting on the 6th December 2010. The following documents were reviewed:

| | | |
|---|---|---|
| 1. | Ethical Amendment Form | 15/12/2010 |
| 2. | Participant Information Sheet | 15/12/2010 |
| 3. | Consent Form | 15/12/2010 |
| 4. | Debriefing Form | 15/12/2010 |
| 5. | Questionnaire | 15/12/2010 |

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Convenor of the School Ethics Committee OR Convener of UTREC

Ccs Prof. David Perrett (Supervisor)
School Ethics Committee

University of St Andrews

University Teaching and Research Ethics Committee
School of Psychology

7 December 2009

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS6035 |
| **Project Title:** | Look at me |
| **Researchers Name(s):** | Milena Dzhelyova |
| **Supervisor(s):** | Prof. David Perrett |

Thank you for submitting your application which was considered at the School Ethics Committee meeting on the 2nd December 2009. The following documents were reviewed:

1. Ethical Application Form 02/12/2009
2. Participant Information Sheet 02/12/2009
3. Consent Form 02/12/2009
4. Debriefing Form 02/12/2009

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Convenor of the School Ethics Committee OR Convener of UTREC

Ccs Prof. David Perrett (Supervisor)
School Ethics Committee

# University of St Andrews

## University Teaching and Research Ethics Committee

27 October 2010

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS6926 |
| **Project Title:** | Facial aspects signalling cooperation |
| **Researchers Name(s):** | Milena Dzhelyova and Tim Brackfield |
| **Supervisor(s):** | Professor David Perrett |

Thank you for submitting your application which was considered at the Psychology School Ethics Committee meeting on the 20th October 2010. The following documents were reviewed:

| | | |
|---|---|---|
| 1. | Ethical Application Form | 26/10/2010 |
| 2. | Participant Information Sheets | 26/10/2010 |
| 3. | Consent Form | 26/10/2010 |
| 4. | Debriefing Form | 26/10/2010 |
| 5. | Invitation to Participate | 26/10/2010 |
| 6. | Questionnaires | 26/10/2010 |

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Convenor of the School Ethics Committee OR Convener of UTREC

Ccs Professor David Perrett (Supervisor)
School Ethics Committee

# University of St Andrews

## University Teaching and Research Ethics Committee

21 April 2011

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS7430 |
| **Project Title:** | Economic Games – attractiveness and head posture |
| **Researchers Name(s):** | Milena Dzhelyova and Amanda Hahn |
| **Supervisor(s):** | Professor David Perrett |

Thank you for submitting your application which was considered at the Psychology School Ethics Committee meeting on the 20th April 2011. The following documents were reviewed:

| | |
|---|---|
| 1. Ethical Application Form | 21/04/2011 |
| 2. Participant Information Sheet and Online Version | 21/04/2011 |
| 3. Consent Form and Online Version | 21/04/2011 |
| 4. Debriefing Form and Online Version | 21/04/2011 |
| 5. Questionnaires | 21/04/2011 |

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Convenor of the School Ethics Committee

Ccs Prof. D. Perrett (Supervisor)
School Ethics Committee

11 September 2012

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS9129 |
| **Project Title:** | Individual differences in preference for health cues in the face |
| **Researchers' Names:** | Carmen Lefevre, Milena Dzhelyova and Amanda Hahn |
| **Supervisor:** | Professor David Perrett |

Thank you for submitting your application which was considered at the Psychology & Neuroscience School Ethics Committee meeting on the 15th August 2012. The following documents were reviewed:

| | | |
|---|---|---|
| 1. | Ethical Application Form | 11/09/2012 |
| 2. | Participant Information Sheet | 11/09/2012 |
| 3. | Consent Form | 11/09/2012 |
| 4. | Debriefing Form | 11/09/2012 |
| 5. | Questionnaires | 11/09/2012 |

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

pp Convenor of the School Ethics Committee

Ccs Prof. D, Perrett (Supervisor)
School Ethics Committee

University of St Andrews

University Teaching and Research Ethics Committee
School of Psychology

9 April 2010

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS6305 |
| **Project Title:** | Temporal Dynamics of Trustworthiness and Gender Judgements |
| **Researchers Name(s):** | Milena Dzhelyova |
| **Supervisor(s):** | Professor David Perrett, Dr Ines Jentzsch |

Thank you for submitting your application which was considered at the Psychology School Ethics Committee meeting on the 7th April 2010. The following documents were reviewed:

| | | |
|---|---|---|
| 1. | Ethical Application Form | 09/04/2010 |
| 2. | Participant Information Sheet | 09/04/2010 |
| 3. | Consent Form | 09/04/2010 |
| 4. | Debriefing Form | 09/04/2010 |
| 5. | Advertisement | 09/04/2010 |
| 6. | Scales | 09/04/2010 |

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Convenor of the School Ethics Committee OR Convener of UTREC

Ccs Professor David Perrett (Supervisor)
Dr Ines Jentzsch (Supervisor)
School Ethics Committee

28 October 2010

| | |
|---|---|
| **Ethics Reference No:** *Please quote this ref on all correspondence* | PS6305 (Amendment) |
| **Project Title:** | Temporal Dynamics of Trustworthiness and Gender Judgements (Ratings Task) |
| **Researchers Name(s):** | Milena Dzhelyova |
| **Supervisor(s):** | Dr Ines Jentzsch, Professor David Perrett |

Thank you for submitting your application which was considered at the Psychology School Ethics Committee meeting on the 28th October 2010. The following documents were reviewed:

| | | |
|---|---|---|
| 1. | Ethical Amendment Form | 28/10/2010 |
| 2. | Participant Information Sheets | 28/10/2010 |
| 3. | Consent Form | 28/10/2010 |
| 4. | Debriefing Form | 28/10/2010 |
| 5. | Invitation to Participate | 28/10/2010 |

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Convenor of the School Ethics Committee OR Convener of UTREC

Ccs Dr Ines Jentzsch (Supervisor)
Professor David Perrett (Supervisor)
School Ethics Committee