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Face Evaluation: An Embodied Cognitive Approach

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"the chief part of human happiness arises from the consciousness of being loved"

Adam Smith,

The Theory of Moral Sentiments

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Resumo

Esta tese tem por objectivo demonstrar que a avaliação de faces pode ser corporalizada. Os estudos na área da avaliação de faces sugerem que a percepção facial está associada à acção. Sendo que as acções dependem dos nossos corpos, a avaliação de faces supostamente influenciará a forma como os nossos corpos irão actuar. Para além disso, pretende-se evidenciar que a acção corporal também pode influenciar a avaliação de faces. Nos três primeiros capítulos empíricos testou-se a noção de que os julgamentos de dominância social resultam de uma generalização de propriedades que sinalizam ao percipiente o potencial de alguém para agir (i.e. força física) o que poderá influenciar as acções corporais. Os resultados indicam que os julgamentos de força física predizem a dominância social. Nos últimos três capítulos empíricos, procurei demonstrar que as acções corporais podem influenciar a avaliação de faces. Demonstrei que uma postura expansiva em comparação com uma postura constritiva pode reduzir a percepção das diferenças entre os níveis faciais de dominância social. Os participantes numa postura corporal expansiva recriaram uma imagem mental do seu eu facial que evidencia uma maior dominância, comparativamente aos participantes numa postura constritiva. Finalmente, evidenciei que a interacção entre os corpos através de uma estimulação multissensorial pode influenciar os julgamentos e o reconhecimento do traço confiável nas faces. Assim, a presente investigação evidencia que a avaliação de faces é corporalizada.

Palavras-Chave: Avaliação de Faces, Cognição Corporalizada, Acção, Propriedades Faciais, Dominância, Confiança.

Abstract

This thesis intends to demonstrate that face evaluation can be embodied. Studies in the area of face evaluation suggest that face perception is linked to action. Given that actions depend on our bodies, face evaluation supposedly influence how our bodies will act. Furthermore, I intend to show that the action of our bodies can also influence face perception. In the first three empirical chapters, I tested the notion that judgments of social dominance result from an overgeneralization of properties that signal to the perceiver the potential for someone to act (i.e. physical strength). This may potentially influence our bodily actions. The results indicate that judgments of physical strength predict social dominance. In the last three empirical chapters, I tried to show that bodily actions can influence face evaluation. I showed that an expansive posture can reduce the perception of differences between facial levels of social dominance when compared to a constrictive posture. Participants in the expansive body posture also recreated a mental image of their self-face evidencing greater dominance than participants in a constrictive posture. Finally, I also demonstrated that the interaction between bodies through a multisensory stimulation can influence judgments and the recognition of trustworthiness in faces. Thus, the present thesis shows that face evaluation is embodied.

Keywords: Face evaluation, Embodiment, Action, Facial Features, Dominance,Trustworthiness.

American Psychological Association (PsycINFO Classification Categories and Codes)

2320 Sensory Perception

2340 Cognitive Processes

3000 Social Psychology

3040 Social Perception and Cognition

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CHAPTER 1

FACE EVALUATION: AN EMBODIED COGNITIVE APPROACH

Is that person friendly or not? Can I trust him? Is he dangerous? Can he inflict harm upon me or help me in my tasks? Such questions reflect the pervasiveness of impression formation (Asch, 1946). It is a fundamental human motivation: to perceive characteristics, intentions and traits of other people in order to know how to act. One of the most important sources of forming impressions and, consequently, informing our actions, are facial cues (e.g. Dotsch & Todorov, 2012; Oosterhof & Todorov, 2008; Willis & Todorov, 2006; Zebrowitz, 2011).

The link between impression formation from faces and human action can be seen, for instance, in the work of Oosterhof and Todorov (2008). They found that impressions from faces can be reduced to two trait dimensions: trustworthiness and dominance. According to this research, face evaluation might be related to actions that serve an adaptive purpose because it signals to the perceiver the intentions and the ability of others to apply those intentions (see also Sutherland et al., 2013). These intentions signal whether someone should be approached or avoided and has the ability to take harmful actions.

In this thesis, I argue that face evaluation mechanisms are grounded in mechanisms that influence physical interactions. Given that the human body is the main agent of interaction with the physical and social properties of the environment (see Glenberg, 2010) and that our actions depend on our bodies, I emphasize the importance of physical action and consequently of our bodies in face perception processes. Thus, this dissertation will be focused on extending embodied cognitive theories to face evaluation.

Embodied cognition theories suggest that "the overriding task of mind is to produce the next action" (Franklin, 1997, p.412). As claimed by Glenberg (1997, 2010), our brains and bodies have evolved to control action. Action is the *sine qua non* for survival. Previous models of face perception and impression formation from faces has almost completely ignored the involvement of concrete physical action. I want to extend models on face evaluation starting with the perspective of Oosterhof and Todorov (2008), who show that impressions from faces are represented by two trait dimensions that serve to act adaptively, and investigate in more detail how face evaluation evolved for action which depends on our bodies. In short, the argument is that face evaluation can be understood as an embodied process (e.g. Glenberg, 1997, 2010; Schubert & Semin, 2009).

The first three studies (**Chapters 2, 3 and 4**) intend to add evidence to the notion that face perception results from the need to act. This reasoning is similar to the ecological approach of face perception of Zebrowitz and collaborators (e.g. Zebrowitz, 2006; Zebrowitz & Montepare, 2008) who posit that "perceiving is for doing" (see Gibson, 1979). This model has its foundations in the notion of affordances (Gibson, 1979). Affordances are defined as what the environment "offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1979, p. 127). From this perspective, cues provided by facial appearance are an opportunity for social relations and guide the perceiver's behavior. For example, the face of a baby may afford caring responses (Zebrowitz, 1997); an attractive face may afford approaching behavior, while unattractive faces may elicit avoidance responses (Marsh, Adams, & Kleck 2005). In line with this reasoning, I suggest that face evaluation serves functional goals that are intrinsically connected to, and grounded in, bodily interactions with the world.

In particular, in these three empirical chapters I will add evidence to the notion that *dominance perception* is related to the identification of individuals who have the ability to cause physical injuries. This will enable the perceiver to increase the levels of protection against threats. Therefore, I posit that dominance evaluation results from the overgeneralization of facial properties that signal physical strength. This would serve an adaptive role and guide the perceiver's behavior, given that the perception of physical strength provides the perceiver with information of someone's physical ability to inflict costs (Sell, Cosmides, et al., 2009). Bodily strong people would also be more likely to win physical contests and gain access to resources. The inability to perceive cues of physical strength would be very costly to perceivers (Sell, Cosmides, et al., 2009). The recognition of strong individuals would afford the perceiver the ability to avoid physical contests and recognize who was more influential and had more resources (Parker, 1974). Therefore, facial dominance perception might serve an adaptive role that guides how we should act in order to navigate through social hierarchies.

More specifically, in **Chapter 2,** I present two studies that aim to show the role of physical strength in social dominance judgments. There, I investigate how physical strength judgments of faces predict dominance judgments. Additionally, I want to show that physical strength and dominance judgments have common facial features predictors in order to demonstrate the similarity of the two traits. In **Chapter 3**, I will use a data-driven approach (Todorov et al., 2013) where I investigate how physical strength and dominance judgments can be physically represented in the human face. Again, my goal is to investigate how similar the two traits are.

In the studies of **Chapters 2** and **3**, the relation between judgments of dominance and physical strength is studied with faces shown from the front and directly gazing at the perceiver. However, in real-world situations we sometimes just see glimpses of other people´s faces and most of the times never see them in this exact position (e.g. Rule, Ambady, & Adams, 2009; Todorov & Porter, 2014). In the five experiments of **Chapter 4**, I will explore how dominance and physical strength judgments are related using more dynamic cues. My aim is to study how dominance and physical strength impressions from faces will vary according to contextual and dynamic changes. Given that cognition evolved to interact with a constantly changing environment, it makes sense to suggest that given the functional role of face evaluation (Oosterhof & Todorov, 2008) the two traits may change according to a specific situation. This will be investigated through the manipulation of gaze direction and head position in face processing (Tipper & Bayliss, 2011), for both dominance and physical strength judgments. Therefore, I want to explore whether both traits have the same dynamic profile. More specifically, I will test whether dominance and physical strength impressions change concurrently according to gaze and head position.

The empirical chapters described above only intend to demonstrate that face perception influences how our bodies should act, but not how bodily actions may change our impressions from faces. In the last three empirical chapters (**Chapters 5-7**), I intend to demonstrate that face evaluation might be influenced by bodily actions. Thus, this new conceptual approach to face perception builds upon the ecological approach that "perceiving is for doing" (see Zebrowitz, 1997), but also posits that doing influences how we perceive (see Schubert & Semin, 2009). In other words, face perception's link to action might be not only unidirectional, but bidirectional. In these chapters, I present studies designed to show the influence of our bodily behavior (e.g. Barsalou, 2008; Schubert & Semin, 2009) on face evaluation.

More specifically, in **Chapter 5,** I intend to show that our body influences how we perceive others. I investigated how a manipulation of the participants' posture (expansive versus constrictive) might influence dominance judgments of faces. Additionally, in **Chapter 6** I investigated this embodiment of power as a mechanism that can alter representations of the own face. These investigations will test the role of bodily feedback in face evaluation. Furthermore, in **Chapter 7**, I will examine how the way our body interacts with other bodies might also influence trustworthy judgments and recognition of faces. I will show in two studies the role of another embodied mechanism (e.g. synchronous rhythmic movement) in trustworthiness judgments and recognition of faces. I intend with these studies to show how judgments and recognition of trustworthiness might be affected by synchrony movements.

Finally, in the last chapter I present a summary of the empirical findings of my research and I discuss them. I will also describe how these findings can contribute to a better approach to the study of face evaluation. Ultimately, I will discuss some limitations of our research and try to show some possible new avenues for future research.

In the remainder of this chapter, I present an overview of how facial appearance may influence personality inferences (Section 1). I will describe the level of accuracy in face perception. More specifically, I will try to show whether there is any link between facial appearance and actual personality. Additionally, I aim to show what might explain the inconsistency between facial properties and someone's personality. Thus, I will present the ecological approach to face perception and how face perception is directly related to action. The ecological approach to face perception posits that "perceiving is for doing". This might explain the overgeneralization mechanisms of face perception (see Zebrowitz, 1997) that could be responsible for inaccuracies in personality judgments from facial cues.

In section 2, I will present how face evaluation can be derived from two trait dimensions: dominance and trustworthiness, and how the inference of these dimensions as mentioned above might be related to adaptive actions (Oosterhof & Todorov, 2008). In section 3, I will show how embodied cognitive processes might influence face evaluation. Finally, in section 4, I present my research goals, explaining how I studied how face evaluation is directly linked to bodily actions.

1.1 Impressions from Faces

1.1.1 Face and Personality Relationship

Although many things can guide a perceiver to form an initial opinion about someone else, none is probably more important than the human face. The face keeps fascinating us. One of the main reasons is the general belief that this part of the body can reveal something about personality. According to the Swiss physiognomist Johann Caspar Lavater (1840), the character of a person could be accurately seen in the face. For instance: “The nearer the eyebrows are to the eyes, the more earnest, deep, and firm the character” (Lavater, 1840, p. 59). In modern days, even if most of the physiognomy principles are completely wrong, studies show that we are prone "to judge a book by its cover" (e.g. Zebrowitz, 1997). Therefore, the way we look influences other people's reactions and behaviors and, consequently, has a large impact in our daily lives. The human face is a vehicle of information that the perceiver uses, in several cases inaccurately, to infer a person's identity, personality, race, and emotional state (Bodenhausen & MacRae, 2006; Zebrowitz, 2006).

The human face has often been described as a window to one's personality (Zebrowitz, 1997). Even today, many people believe that the human face is the mirror of our character. When asked to say whether one can accurately judge traits from faces, 72% of participants believed so (see Zebrowitz, 1997). However, the evidence for the accuracy of these inferences is mixed. Hollingworth (1922) and Laird (1927) were among the first to study the relationship between perceived and actual intelligence. These studies revealed some incongruities: one showed a relationship whereas the other did not. More recently, some studies demonstrated that perceived intelligence may have a relationship with actual intelligence but only for people with below average attractiveness (Zebrowitz & Rhodes, 2004). However, Kleisner, Chvátalová and Flegr (2014) after measuring the IQ were able to demonstrate that perceived intelligence from the human face is related with IQ for men, but not women.

Other personality traits were also studied. Extraversion and health seem to be accurately estimated from the face alone (Kramer & Ward, 2010; Penton-Voak, Pound, Little and Perrett, 2006). Facial dominance could also predict the military ranking of West Point cadet (Muller & Mazur, 1997 – but see Loehr & O’Hara). CEOs' facial appearance is related to their companies’ success (Rule & Ambady, 2008a, 2009). Additionally, physical strength can be predicted from inferences from faces (Sell, Cosmides, et al., 2009). Furthermore, sexual orientation seems to be guessed better than chance from facial appearance (Rule & Ambady, 2008b), and the same is true of political orientation (Rule & Ambady, 2010; Samochowiec, Wanke, & Fiedler, 2010). On the other hand, big-five traits such as agreeableness and conscientiousness were not judged accurately from the face (Pound, Penton-Voak, & Brown., 2007), and we are also not able to predict one's honesty from the face (Zebrowitz et al., 1996).

However, how strong are these links? Recently, it was suggested (Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2014) that some of the evidence suggesting accurate personality assessment from facial observation has been exaggerated. For instance, Olivola et al. (2014c) found that the accuracy of identifying Democratic and Republican politicians is not better than chance when controlling for gender, ethnicity and age. Additional evidence also demonstrates that the way participants thought that certain leaders performed and their actually performance was inconsistent (Olivola, Eubanks, & Lovelace, 2014b). Besides that, some studies that aim to demonstrate links between facial judgments and personality do not take into account that pictures of the same individual vary enormously (Jenkins et al., 2011; Todorov & Porter, 2014). For instance, Jenkins and collaborators (2011) showed a great variation in attractiveness judgments of the same individual. More specifically, the attractiveness of the same person varied when seen by others depending on the image that was shown. The judgments of attractiveness were not consensual across the different images of the same person. In line with this reasoning, Todorov and Porter (2014) demonstrated the same pattern for seven trait judgments. Judgments varied tremendously across different images of the same individual. What the evidence clearly shows is that whether trait judgments from faces are accurate or not; we consistently, rapidly and effortlessly form impressions based on the human face. In the next section, I will describe why people keep inferring traits from faces even when their judgments are inaccurate.

1.1.2 "Perceiving is for doing": The Ecological Approach to Face Perception

The most important theoretical framework that tries to explain why people form impressions from faces the way they do, even when they are inaccurate, is based on the ecological approach of Gibson (1979) was developed by Zebrowitz and collaborators (e.g. Zebrowitz, 1997; Zebrowitz, 2011; Zebrowitz, Bronstad, & Montepare, 2011; Zebrowitz & Montepare, 2008). One of the most significant principles of the ecological approach to face perception is that "perceiving is for doing" (Gibson, 1979). Face perception is directly connected to action. Thereby, it helps us to guide our behavior in a social and physical challenging environment. Moreover, the way we adaptively respond to facial cues is associated with the notion of affordances. Thus, face perception prepares and allows us to act in a certain manner. For instance, the face of a threatening person affords us to act in an avoidant way; a face resembling a likable familiar person may afford friendly behavior (see Zebrowitz, 2011). Therefore, the ecological approach says that we possess a very well developed or innate ability to attune to stimulus information that is functionally adaptive. (Zebrowitz, 1997, p.12) wrote:

> *It is assumed that impressions of people that are based on their appearance must be useful inasmuch as these impressions guide our social behavior, which, more often than not, is relatively effective in achieving our goals. Therefore, face reading either should be accurate or should reflect perceptual biases that serve some general adaptive function.*

The affordances transmitted by facial appearance can lead to overgeneralized and sometimes inaccurate perceptions. These overgeneralized responses can lead us to erroneously associate facial characteristics that resemble such categories as babies, emotional states, low fitness, identities and/or a specific animal to personality characteristics. Therefore, certain traits that are accurately paired with facial cues which reveal specific traits such as low fitness, babyfaceness, certain identities or features, emotional problems, or are more closely associated with animals, are also perceived in persons whose faces resemble the same. Some theorists posit that we keep inferring traits even when we are wrong because of overgeneralization mechanisms. According to the ecological theory, the inaccuracies resulting from such overgeneralizations might occur because it might be less dangerous to act that way than to fail to react accordingly to unfit individuals, babies, identities, animals or to a precise emotional situation (see Zebrowitz, 1997;

Zebrowitz, 2011; Zebrowitz et al., 2011). These overgeneralizations play an important role in how face evaluation guides our actions.

1.1.3 The Overgeneralization Processes

1.1.3.1 The Anomalous Overgeneralization Hypothesis

This overgeneralization hypothesis explains how the response to facial characteristics that signal (or do not signal) fitness influences attractiveness judgments. Zebrowitz and Rhodes (2004) suggested the anomalous face overgeneralization hypothesis, which proposes that we are very sensitive to individuals that have diseases. Consistent with this, attractive faces have been associated with high fitness. Attractive faces are usually average, symmetric and younger. Averageness and symmetry are both signals of a normal development and a strong resistance to pathogens. Besides that, youthfulness is a sign of greater cognitive and physical ability.

Consistent with the anomalous overgeneralization hypothesis, more asymmetric faces and faces that deviate more from the average are perceived as less intelligent and healthy (Zebrowitz, Hall, Murphy, & Rhodes, 2002; Zebrowitz & Rhodes, 2004). Additionally, faces of older people are considered as less attractive, warm and healthy than younger faces (Montepare & Zebrowitz, 2002). Older faces seem to resemble anomalous faces more (Zebrowitz, Fellous, Mignault, & Andreoletti, 2003).

1.1.3.2 The Babyface Overgeneralization Hypothesis

Facial impressions are also influenced by babyfaceness, or in other words, whether someone has facial cues that resemble babies. Therefore, babyfaced individuals tend to be judged are having more child-related characteristics. For instance, they are considered to be more naive, less dominant, and warm than people with faces low in babyfaceness. The ecological approach of social perception posits the existence of a babyface overgeneralization process that makes us intrinsically prepared to infer characteristics about baby facial cues, but also to then overgeneralize to adults (Montepare & Zebrowitz, 1998).

Some authors (Keating, 2002; Montepare & Zebrowitz, 1998) suggest that babyfaceness is associated to certain facial features. These features are: larger eyes, higher eyebrows, smaller noses, higher forehead, shorter chin and a rounder face. The manipulation of these features is related to attribution of traits related to babyfaceness. Zebrowitz et al. (2003) also showed through a neural network that adult faces more similar to babies were judged as having more traits related to babies, like submissiveness, naiveté and physical weakness.

1.1.3.3 The Emotion Overgeneralization Hypothesis

Emotions also play a vital role in impression formation. Secord (1958) hypothesized that perceivers use facial expressions of emotions to attribute personality traits. He called this process temporal extension, by which "the perceiver regards a momentary characteristic of the person as if it were an enduring attribute" (p. 307). Therefore, a happy person may be seen not only as temporarily friendly but also as having the friendly trait as a persistent characteristic of personality.

In line with this, Knutson (1996) showed that some facial expressions are associated with the inference of certain traits. Participants inferred high dominance and affiliation from happy expressions. Moreover, angry and disgusted expressions yielded inference of high dominance and low affiliation. Fear and sadness were associated with low dominance judgments. Therefore, emotions convey information that may lead to specific trait inferences.

Angry expressions usually create impressions of high dominance. For instance, Keating, Mazur and Segall (1981) have shown that the single manipulation of the eyebrows, a facial feature involved in the expression of anger, may increase the perceived dominance of a target. This occurred only for Western participants. Additionally, research that studied primitive masks from various cultures revealed that diagonal and more angular forms increased the perception of anger and threat (Aronoff, Woike, & Hyman, 1992). Marsh et al. (2005) also found that angry facial expressions were judged as more mature, dominant and strong than fearful facial expressions.

However, it seems that not only momentary emotional expressions influence trait impressions, but also that the similarity of one’s facial configuration to an emotion influences the perceived qualities of a person. In the ecological approach, this is referred to as the emotion overgeneralization hypothesis (e.g. Zebrowitz, 1997). The adaptive role of identifying particular emotional expressions has prepared us to respond to certain facial characteristics that transmit certain emotions. The identification of these emotions leads us to overgeneralize about persons whose faces merely resemble a particular facial emotional expression. Montepare and Dobish (2003) were able to show that faces with a neutral expression but a resemblance to some facial expressions yielded specific trait impressions. For instance, neutral faces that resembled anger elicited an impression of low affiliation, whereas neutral faces resembling happiness created a more positive impression, eliciting higher affiliation. Facial structure also influences the intensity of perceived emotion. Therefore, a more dominant looking person with an anger expression is seen as angrier than a person with a less dominant facial structure. Similarly, a more trustworthy looking person who expresses happiness will be judged as happier than an untrustworthy person with the same expression (Said, Sebe, & Todorov, 2009). Thus, it seems that processes of emotion perception can not only lead to the identification of behavioral intentions, but also elicit the attribution of certain traits.

However, the relation between particular emotions and certain traits might be related to semantic similarities. More precisely, a trustworthy face may be judged as happy not because happiness and trustworthiness resemble each other, but because there is a semantic relation between the two words, trustworthiness and happiness. To disentangle this, Said et al. (2009) used a Bayesian network classifier that was trained to detect the presence of emotions in faces. This classifier permits to show that traits objectively resemble emotions. Therefore, the goal was to demonstrate that the association between certain traits and emotions was not the result of any semantic association. The researchers found that the trained classifier was able to demonstrate that certain emotions were correlated with the trait judgments of the participants. Therefore, happiness was positively correlated with positive traits (e.g. caring, responsible) and negatively correlated with all negative traits (e.g. threatening, aggressiveness, meanness). Anger was positively correlated with dominance, whereas fear had a negative correlation with dominance. Additionally, the chance of an emotion being classified as disgust was positively correlated with some negative trait judgments (e.g. mean or weird) and negatively correlated with other positive characteristics (e.g. intelligence or confidence). In sum, this Bayesian classifier showed that people objectively tend to overgeneralize from emotions to trait judgments. This gives more support to the emotion overgeneralization hypothesis.

1.1.3.4 The Familiar Face Overgeneralization Hypothesis

Facial familiarity may also influence impressions of faces. According to the familiar face overgeneralization hypothesis (e.g. Zebrowitz, 1997; Zebrowitz & Montepare, 2008) people in some cases create impressions of strangers based on how much they resemble familiar people. For example, DeBruine (2002) showed that in a trust game, participants tended to trust others more who had a stronger resemblance to themselves. Moreover, recent experience is also pertinent; participants tended to prefer job candidates whose faces resembled someone who had just been warm to them than a job candidate whose face was similar to one whose behavior was unfriendly (Lewicki, 1985). The familiar face overgeneralization hypothesis may also be related to impressions based on race. For instance, negative impressions of an outgroup are larger when there is a lack of familiarity with other-race faces. Increases in familiarity with outgroup faces decreases the negative stereotypes associated with the outgroup (Zebrowitz, Bronstad, & Lee, 2007). Unknown persons that do not resemble familiar individuals tend to facilitate negative responses (Zebrowitz, 1997).

1.1.3.5 The Species Face Overgeneralization Hypothesis

The species face overgeneralization hypothesis (see Zebrowitz, Wadlinger, Luevano, White, Xing, & Zhang, 2011) posits that humans' facial resemblance to different animals influences the impression. That is, the traits normally associated with specific animals are attributed to people whose faces resemble those animals. For instance, lions are, usually, considered as more shrewd, dominant and cold. People with leonine faces were more likely to be judged as having those traits. Furthermore, similarity with some species of dogs (e.g. Labrador retrievers) led participants to judge faces according to traits associated with those dogs: participants considered these persons to be warmer and less shrewd.

Thus, a leonine and canine appearance seems to provoke species face overgeneralization. A strong preparedness to respond to kinds of animals acquired during the course of human evolution may lead us now to overgeneralize about people whose faces resemble animals based on cultural characteristics attributed to those animals (Zebrowitz et al., 2011).

1.1.4 Action-Oriented Perception

The overgeneralization mechanisms demonstrate that face perception has prepared us to respond in a certain manner to specific facial properties. The ecological approach to face perception suggests that "perceiving is for doing". Face perception is strongly associated with adaptive action that guides our behavioral responses. The ecological approach ties perception to action. Therefore, face perception is directly related to behavioral responses. For instance, perceivers behave favorably towards attractive persons from working settings to court decisions (Zebrowitz, 2011). Moreover, approach behavior tends to be associated with attractive persons while unattractive persons trigger more avoidance responses (Marsh et al., 2005).

Additionally, different facial expressions change our physiological states in order to prepare us to act (Zajonc, Murphy, & Inglehart, 1989). Therefore, different emotional expressions exist because they prepare us for a given situation. Marsh and collaborators (2005) posit that the association between certain emotional expressions and trait impressions are related to the adaptive role of facial maturity mimicry. According to them, it is adaptive for someone who is afraid to resemble a baby's in order to be helped. Conversely, when someone feels anger, it may be adaptive to assume a facial expression that resembles the appearance of a dominant and powerful person. To look this way can provoke powerful responses in others, because the perception of emotion influences behavior. For instance, anger expressions increase aversive classical conditioning (Dimberg, 1986; Ohman & Dimberg, 1978). Avoidance behaviors increase with anger expressions, while the reverse is true for fear expressions (see Marsh et al., 2005). Fear expressions also facilitate startle responses already in five-month-old infants (Balaban, 1995).

Babyfaced people also elicit certain actions from others. They tend to prompt more affect and protective behavior. In such a vein, babyfaced individuals are less considered for high status positions. Additionally, facial appearance might bias participants' judgments in real life from court decisions to elections (Blair, et al., 2004; Eberhardt, et al., 2006; Little, Burriss, Jones, & Roberts, 2007; Todorov, Mandisodza, Goren, & Hall, 2005; Zebrowitz & McDonald, 1991). For instance, Zebrowitz and McDonald (1991) have shown that sentencing decisions are harsher on dominant-looking defendants when the plaintiffs have a babyface. Moreover, persons whose faces resemble the criminal stereotype are more likely to be chosen in a police lineup (Flowe & Humphries 2011).

Face perception also influences our sexual behavior through its influential role in mate choice. Olivola et al. (2014a) found that success in finding sexual partners through dating websites can be influenced by facial judgments. More specifically, faces considered fun and outgoing predicted dating success for men while being judged as serious and smart negatively predicted mating success for women.

Trustworthiness judgments from faces can also influence our financial behavior (Rezlescu, Duchaine, Olivola, & Chater, 2012; Schlicht et al., 2010). For instance, Rezlescu et al (2012) found that people invested more money when the other partners in the deal were facially trustworthy. Curiously, this effect persisted even when the participants received information about the financial record of their partners.

In sum, the ecological approach to face perception suggests that face evaluation influences our behaviors by preparing us to act in a certain fashion. The notion that "perceiving is for doing" (Gibson, 1979) strongly associates face perception to action.

The approach of Leslie Zebrowitz and collaborators (e.g. Zebrowitz et al., 2011; Zebrowitz & Montepare, 2008) shows that many trait impressions from faces serve an adaptive role. However, it does not provide us with a unified theoretical structure for explaining the multiple trait inferences derived from face perception. Therefore, in order to provide a more parsimonious account and theoretical framework for the trait dimensions underlying face evaluation, Oosterhof and Todorov (2008) argued that impressions from faces might vary primarily on only two trait dimensions: trustworthiness and dominance. Importantly, these dimensions seem to serve an adaptive function that is related to overgeneralization processes, and are thus consistent with the approach of Zebrowitz and collaborators (e.g. Zebrowitz et al., 2011; Zebrowitz & Montepare, 2008). In the next section, I will document the two dimensional model of face evaluation (Oosterhof & Todorov, 2008) that adds even more evidence to the notion that face perception is related to adaptive actions.

1.2 Face Evaluation Model - The Functional Nature of Face Perception

1.2.1 The two dimensional model

Facial judgments are highly correlated with each other (Willis & Todorov, 2006). Therefore, if a person is considered trustworthy he/she will probably be judged as attractive and likeable. Given this, Oosterhof and Todorov (2008) tried to find the fundamental dimensions of face evaluation. First, they asked a group of participants to freely describe personality traits that can be inferred from a face. They collected more than 1000 descriptions. Second, independent judges classified these descriptions into trait dimensions. Fourteen traits were selected, and the trait *dominant* was added given its importance in various models of person perception (Wiggins, 1979). Third, participants judged neutral faces on these traits. Finally, the judgments were submitted to a Principal Component Analysis (PCA). They found two trait dimensions that accounted for more than 80% of the variance of judgments from faces.

The first trait dimension was responsible for 63.3% of the variance and the second trait dimension for 18.3% of the variance. All the positive traits (e.g. trustworthy, caring) loaded positively and all the negative traits (e.g. mean, aggressive) loaded negatively on the first trait dimension. Because the judgments of trustworthiness were the closest in relation to this dimension, the authors considered trustworthiness as the first dimension of face evaluation. The second trait dimension showed these traits: dominant, aggressive and mean as the most positively loaded. Additionally, the trait *dominant* seemed to be the most central (highest correlation with the second trait dimension - 0.93). Consequently, dominance was regarded as the second dimension of face evaluation. More recently, these dimensions were also seen as underlying face evaluation (Sutherland et al., 2013). Besides dominance and trustworthiness, they also found an age dimension.

These findings are consistent with other person perception models. Almost six decades ago, while studying the way people evaluated concepts, some researchers found three universal dimensions: evaluation, potency, and activity (Osgood, Suci and Tannenbaum, 1957). Evaluation is related to how good or bad a person is. Physical strength (i.e. whether a person is strong or weak) defines potency. Perceived tendency towards dynamism in social situations is what defines the activity factor. Curiously, models of interpersonal perception have shown a similar pattern. Wiggins and collaborators (1989) proposed the Interpersonal Circumplex model, a trait taxonomy which showed how personality traits were interrelated. This model posits that two orthogonal dimensions underlie person perception: affiliation and dominance (see also Rosenberg, Nelson, and Vivekananthan, 1968). Additionally, models of intergroup perception showed a strong resemblance to this model. Stereotypes seem to be judged in two dimensions, warmth and competence (Fiske, Cuddy & Glick, 2007). Humans being social creatures it is adaptive to have an apparatus that has enabled us to perceive the other as someone who is good or bad (i.e. whether a stranger has good or bad intentions) and whether those good or bad aims can be put in action (i.e. ability to act in a good way or to harm). Thus, these enabled us to see if a stranger is a potential danger or not, and whether or not the other is capable of inflicting harm.

As multiple lines of impression formation research, face evaluation seems to be related to a strong preparedness to act. In line with the ecological approach principle that "perceiving is for doing", the dimensions underlying face evaluation seem to be interconnected to bodily action. More precisely, face evaluation seems to be related whether we should approach or avoid interaction with someone - the trustworthiness dimension - and whether someone can act harmfully or not upon us - the dominance dimension. Face evaluation is functionally adaptive (Oosterhof and Todorov, 2008).

1.2.2 Modelling Trustworthiness and Dominance - More Evidence for Overgeneralization Mechanisms

Oosterhof and Todorov (2008) also wanted to know how the dimensions underlying face evaluation could be physically represented. As Zebrowitz and collaborators (e.g. Zebrowitz, 2006; Zebrowitz & Montepare, 2008), they also demonstrated that the two trait dimensions could result from overgeneralized responses. To achieve this goal, Oosterhof and Todorov (2008) used the face space model (Valentine, 1991). This model states that faces can be represented in a two-dimensional coordinate system. After judging faces, the differences between them can be visualized by their position. If two faces are closer it means that they show many similarities, while the reverse is true when they are far apart. Thus, we can interpret visually the facial features that caused the differences and similarities in judgments of a specific characteristic of faces.

Furthermore, advances in computer science enable the psychological research of faces to be even more detailed. Blanz and Vetter (1999, 2003) in the first step used a laser scanning real faces to create three- dimensional models of faces. In the next step, they computed an average face in terms of shape and texture. This average face could be manipulated in the multidimensional space. Each face is represented by a shape and reflectance (i.e. texture) vector.

To these vectors a principal component analysis (PCA) is applied. This analysis allows the reduction of dimensions and shows the most common properties in face shape and reflectance. In the end, each face is represented by an average face and the sum of each shape and reflectance dimension. In this face space, we can add new vectors to the faces by adding Gaussian values. Consequently, an unlimited number of faces can be created with this method. Moreover, shape and reflectance can be independently manipulated in order to build vectors that enable the visual representation of specific traits. As a result of this, they were capable of creating a morphable face model. More specifically, by knowing the average face shape and texture of a specific judgment, they were able to create an unrestricted set of combinations that enable them to visualize in a morphable face model how a face changes in terms of shape and texture in relation to a specific judgment. For instance, they could create an average face of a specific trait (e.g. dominant) and visualize in the face space model how the face changes when has more or less of a trait (see Todorov & Oosterhof, 2011).

Using this face space model as the foundation for their study, Oosterhof and Todorov (2008) tried to build facial models for the representation of the two dimensions of face evaluation: trustworthiness and dominance. For these models, they manipulated the 50 dimensions that represent face shape in FaceGen, software which is itself based on the face space model (www.facegen.com). First, they asked participants to judge computer-generated faces (Facegen Main Software Development, 2006) on trustworthiness and dominance. For each face, judgments of each trait (i.e., dominance and trustworthiness) were averaged. After this, a normalized face control was used to manipulate the trait judged by adding the weight of facial components and the rating vector from where the mean of the trait was subtracted (see details, Todorov & Oosterhof, 2011). The goal was to see how these two dimensions varied in terms of shape. The representation in the face space model used the average judgments of each one of the faces for each one of trait dimensions. The mapping of these judgments in the model enabled them to represent the faces and see how the trait dimensions are physically represented. In other words, averages of participants' judgments can again be visualized by rendering another computer-generated face. To see whether the face models were accurate, they asked the participants to rate the new identities that varied across multiple levels (-4.5, -3, -1.5, 0, 1.5, 3, 4.5 *SD*) of both of the traits of trustworthiness and dominance. The participants' judgments tracked the trustworthiness and dominance predicted by the statistical models.

More importantly, these statistical face models are able to show the physical representation in the human face in both dimensions. Therefore, the trustworthiness dimension seems to be related with emotional expressions. Faces at the negative extreme of trustworthiness seem to express anger, while those at the other end seem to express more happiness. The facial shape of dominance seems to be more related to cues of physical strength. Non dominant faces look more feminine and babyfaced whereas the dominant faces look more masculine and mature. These results suggest that underlying face evaluation are the emotion and babyface overgeneralization hypothesis. Therefore, this data-driven approach permits us to clearly see how the structure of faces changes from very untrustworthy/non dominant to very trustworthy/dominant. This modelling of face perception can then be used to see the underlying face cues of specific traits.

However, it is important to find out whether the physical representation of the two dimensions underlying face evaluation is similar for natural faces. The face space model used (Oosterhof & Todorov, 2008; Todorov & Oosterhof, 2011) was based in a limited set of faces (i.e., N = 271). This might have constricted the physical representation of each trait. Moreover, the computer-generated faces did not have hair, which might affect person perception (see MacRae & Quadflieg, 2010). In order to see whether the face space model used can be extended and validated, it would be important to replicate it with other techniques.

The method used by Oosterhof and Todorov (2008) is essentially a reverse-correlation technique. Recently other reverse correlation techniques have been extensively (Gosselin & Schyns, 2003; Mangini & Biederman, 2004; Dotsch, Wigboldus, Langner, & van Knippenberg, 2008; Imhoff & Dotsch, 2013). The typical reverse correlation task is characterized by asking the participants to judge faces or select a face from a pair on a specific characteristic of interest. The faces are based on a distorted base face with superimposed random noise. Based on a participant's judgments, a classification image is created by averaging the pictures that were judged or selected as more representative of the characteristic of interest (or, more specifically, by averaging the judgments and creating another face using those averages). This method enables researchers to generate images that basically visualize participants' mental image of the characteristic of interest (see Todorov, Dotsch, Wigboldus, & Said, 2011).

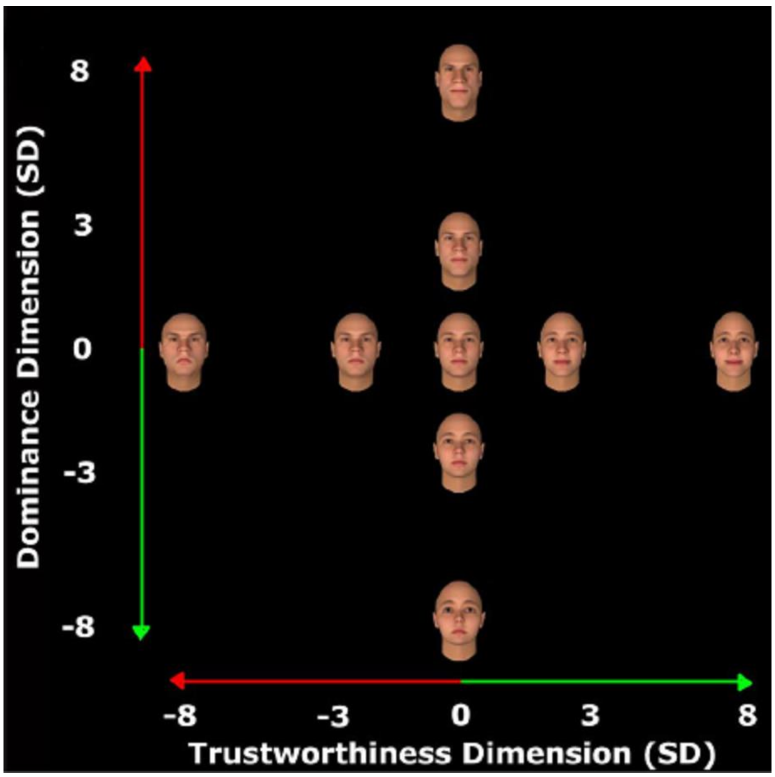

Figure 1.1: Example of a face changing along the Trustworthiness and Dominance Dimensions (Oosterhof & Todorov, 2008)

Mangini and Biederman (2004) demonstrated that this method can be used to study diverse characteristics of interest (e.g. gender, emotions and identities). For instance, in one of the experiments, participants were asked to identify faces as male or female. The base face was a morph of a female and a male face. As previously described, random noise was applied to this morph. When participants had to select a female image, the resulting average classification image was an actual image of a female. In contrast, the classification image was a male when participants were asked to select a male face. In this case, this method enabled to see approximately how female and male faces are internally represented.

More recently, this method was used to investigate how the mental representation of faces of stereotyped groups depends on level of prejudice (Dotsch, Wigboldus, Langner, Knippenberg, 2008). More prejudiced participants had a more negative facial mental representation of Moroccan immigrants (the stereotyped group). These faces looked more untrustworthy and criminal than the mental representations generated by participants with less prejudice towards Moroccans. In general, ingroup members' faces tend to be represented as more positive than outgroup members' faces (Ratner et al., 2014). Cultural differences in perceiving emotional expressions have also been identified with this method (Jack, Caldara, & Schyns, 2012).

More importantly for my purposes, we are able to compare outcomes using this reverse correlation techniques on how dominance and trustworthiness are represented based on the results described earlier that relied on a face space model (Oosterhof & Todorov, 2008; Todorov & Oosterhof, 2011). In order to investigate how trustworthy faces and dominant faces are mentally represented, classification images were generated after averaging the faces that were selected as more trustworthy, untrustworthy, dominant and submissive (Dotsch & Todorov, 2012). The authors found evidence that converges with the face space model: dominant faces seem to be more masculine and mature. Trustworthiness seems again to be more related to positive emotional expressions. In sum, various methods show converging evidence in the representation of the dimensions underlying face evaluation.

I have outlined that face evaluation is based on two dimensions, trustworthiness and dominance. These dimensions can represent multiple social judgments based on faces. Moreover, the facial cues used for each dimension serve an adaptive purpose: to infer behavioral intentions and the ability to apply these intentions from corresponding emotional and maturity cues (Oosterhof & Todorov, 2008; Todorov, Said, Engell, & Oosterhof, 2008). This is consistent with the previously described ecological approach of face perception of Zebrowitz and associates (e.g. Zebrowitz et al., 2007; Zebrowitz & Montepare, 2008), which also posited the relationship between face perception and adaptive actions. Importantly, the overgeneralization mechanisms described by Leslie Zebrowitz seem to encompass the Oosterhof and Todorov (2008) model. More specifically, it seems that overgeneralized responses to emotional and dominance cues are the basis of personality impressions from faces. Therefore, it seems that face perception is intrinsically related with the extraction of information that has a useful purpose. Importantly, it appears that face evaluation is tied to action. The inference of trustworthiness is related to whether one should approach or avoid another person and the perception of dominance signals whether one should run or fight another person. Thus, the two dimensional model goes hand in hand with the notion of the ecological approach that "perceiving is for doing". Nonetheless, the necessity for action while perceiving faces, which is present in the ecological approach and is inherent to the two dimensional model, seems to give only relevance to broad categories of how bodies may act. How the actual actions of bodies may influence how we perceive traits from faces is absent from these studies. In the next section, I will introduce my approach to face perception that tries to give a central role to bodily actions in face evaluation. This new theoretical proposal to face evaluation is based on the embodiment theories (e.g. Barsalou, 2008; Glenberg, 2010; Schubert & Semin, 2009). I will try to show that face perception not only influences how people relate to others in general, but also that how people act with their bodies influences face perception.

1.3 A New Approach to Face Perception: Embodied Cognitive Theories

In this dissertation, I intend to show that face evaluation depends on actions that bodies perform, and is mediated by our bodies, or, in other words, grounded in bodily behavior. As described before, multiple lines of research suggest that across diverse cultures and times social perception seems to reflect two main survival questions. First, is this stranger a friend or foe? Second, does the stranger have the ability to harm me? This makes sense in terms of human evolution. It is essential to detect quickly if someone is trustworthy because he or she may act dishonestly which can implicate great costs to someone. Additionally, it is also important to detect if he or she is capable of hurting me physically. The role of embodied mechanisms in face perception will be thoroughly studied in this thesis.

1.4.1. The Embodied Nature of Cognition

In line with the reasoning of the ecological approach to face perception that posits that perception serves to take actions that are adaptive, I want to expand the literature of face perception by introducing embodied cognitive theories to face evaluation. I intend to demonstrate the central role of bodily action for impressions from faces. In the next section, I will show the embodied mechanisms from these theories that may change how we perceive faces (e.g. Schubert & Semin, 2009).

Some cognitive theories give relevance to the notion that social cognitive processes are embodied (e.g. Schubert & Semin, 2009). According to this approach, cognitive processes are influenced by interactions between the body, environment and behavior.

Cognition has long been viewed as a modular system separated from perception, action and introspection modules (e.g. Glenberg, 2010; Schubert & Semin, 2009). The classical approaches during the cognitive revolution were mostly inspired by advancements in artificial intelligence and computer science (Arkin, 1998). This theoretical background served to define knowledge representation as mere symbols that did not possess any sensorimotor properties (Barsalou, 2008). Therefore, as in computer science, the representation of objects, schemas and semantic networks was assumed to work through binary codes (e.g. Landauer & Dumais, 1997). These cognitive theories assume a clear divide between concepts that are in a modular semantic system and the modality-specific systems of perception, action and introspection. Knowledge was considered to be derived from representations in the modal systems that are converted to abstract symbols. These cognitive theories suffer from the symbol grounding problem (Harnad, 1990) given that knowledge representation is not based on the sensorimotor interactions that we have in the world.

Recent research has been accumulating evidence that cognition seems to be grounded: Knowledge seems to have a much stronger perceptual basis than previously thought (e.g. Barsalou, 1999, 2008; Lakoff & Johnson, 1980, 1999). In this view, cognition is thought to be grounded in various ways: modality-specific systems, physical and social environment, and body and action.

Modality-specific systems refer to the notion that concepts are grounded in modal systems for vision, audition, taste, or other sensory modalities. For instance, the representation of the colors of a painting is performed in color areas of the visual system. Moreover, words are also modality specific. The type of perceptual input changes the way words are encoded. More specifically, switching costs occur when moving from thinking about one modality (e.g. visual) to another (e.g. taste). Thus, participants are slower to identify the word *tart* (i.e. a taste) as a property of the concept APPLE if they had seen before APPLE paired with green (i.e. visual). However, participants will be faster if the property paired with the concept is from the same modality (e.g. shiny which is visual modality). This occurs because perceptual simulations are used to represent concepts (Pecher, Zeelenberg, & Barsalou, 2003, 2004). The visual simulation used in the first place to represent the concept will facilitate the association of visual properties. However, it slows the processing of properties that are not from a visual modality.

Additional evidence for the use of perceptual simulations in knowledge activation shows that the shape of a concept (e.g. animal or object) is activated during language comprehension (Zwaan, Stanfield, & Yaxley, 2002). Some studies also demonstrate that visual areas become active during word comprehension (Kan, Barsalou, Solomon, Minor, & Thompson-Schill, 2003). Interestingly, reading words like “jasmine” and “garlic” activate the olfactory cortex (Gonzalez et al., 2006). Therefore, it seems that conceptual knowledge contains sensorial information that is activated while processing information.

Cognition is also grounded in bodily actions. Bodily conditions and movements may interact with cognition. One of the earliest studies showing how the body shapes cognition showed that head movements can influence how we process messages. The content of a message was considered as more persuasive when participants made vertical movements with their heads than when they moved the head horizontally (Wells & Petty, 1980). Whether we nod in agreement or shake our heads influences our preferences (Tom et al., 1991). Additionally, the way we move our arms alters the way we evaluate. The movement of one’s arm towards oneself (i.e. approach behavior) leads to a more positive evaluation than an arm extension movement (i.e. avoidance behavior; Cacioppo, Priester, & Berntson, 1993). In line with this, Chen and Bargh (1996) showed that participants were faster in their approach behavior (i.e. pull a lever towards oneself) when they saw stimuli that had positive valence and faster in their avoidance responses (i.e. pull a lever away from oneself) for negative stimuli.

Additional evidence for the role of action mediated through the body comes from the work of Glenberg and collaborators. Glenberg and Kaschak (2002; see also Glenberg et al., 2008) showed that people engage in action simulation while understanding sentences. Participants were faster to consider a sentence as sensible when the action was compatible with the meaning of the sentence. For instance, when they read the sentence ‘Art gives you the pencil’ they were faster to judge whether the sentence made sense if they had to answer by moving their hands toward their own bodies. When reading the sentence ‘You give Art the pencil’ the reverse was true, that is, they were faster when they had to move their hands away from the body. Furthermore, neuroimaging studies showed that motor areas are activated by reading action-related sentences (Tettamanti et al., 2005). Greater activation is also seen in motor areas related with hands movement when listening to the verb ‘pick’ and greater activation of face movement areas when listening to the word ‘lick’ (Hauk, Johnsrude, & Pulvermüller, 2004).

In line with the idea that bodily actions are associated with cognition, research also found that facial feedback influences judgments. Facial expressions were manipulated by asking the participants either to hold a pen between their teeth (a smiling expression was activated) or to put a pen between their lips (inhibition of smiling). The "smiling" participants find cartoons more amusing than the "non-smiling" participants (Strack, Martin, & Stepper, 1988). In another experiment, people whose task was to make "ü" sounds in German (which activates an expression of disgust) declared more unpleasant feelings (Zajonc, Murphy, & Inglehart, 1989). Furthermore, postures also change cognitive thinking. Participants felt more well-being and less stress in an upright posture compared to a slumped posture (Riskind, 1984; Risking and Gotay, 1982). When people received their tasks results in an upright posture they felt prouder than in a slumped posture (Stepper & Strack, 1993). Additionally, participants felt more power when they were in expansive (i.e. spread of the legs and arms; upright posture) than in a constrictive (i.e. a curved upper-body; body closed inward; limbs closed) posture. Moreover, an expansive posture increases the level of testosterone and tolerance for risk and at the same time decreased levels of cortisol (Carney, Cuddy, & Yap, 2010).

From this, two notions of embodiment or grounding can be drawn. On the one hand, the way the body interacts with the physical environment will causally shape the concepts people have. This will be true both phylogenetically, over the course of evolution, and ontogenetically, over the course of an individual's development. Concepts that are central and important to human interaction, and universally held, are likely to emerge from crucial interactions of the body with the physical and social environment. That implies that we should be able to trace back important concepts to their embodied origin – to find out how they are grounded. On the other hand, embodiment theories argue that the concepts formed in this process are not abstracted and schematized into amodal mental representations. Instead, they argue, concepts retain their links to modal representations, including motor actions. This connection of concepts to motor representations can explain the evidence just cited. In sum, I derive two notions of embodiment here: important concepts will be derived from bodily interactions with the environment, and such concepts will keep their link to modal, including motor, representations.

1.4 The Present Dissertation

Given the important role of bodily action in cognition (e.g. Glenberg, 2010; Schubert & Semin, 2009), it seems odd that the link between perception and action in face perception has been limited to the notion that the way we perceive may influence relational behavior in general. Thus, the ecological approach to face perception seems to have a gap in its theoretical conception because it does not take into account nor provides empirical support for the argument that face perception is grounded in motor action just as other cognitive processes are, and that human bodily actions may also impact face evaluation. I suggest in this thesis a comprehensive new conceptual approach based on the recent findings of the embodiment theories that will try to give a central role to bodily action in face evaluation.

As described above, the ecological approach to face perception hypothesizes that "perceiving is for doing" (e.g. Zebrowitz, 2006; Zebrowitz & Montepare, 2008, Zebrowitz, 1997; Zebrowitz, 2011). Therefore, face perception is associated with action. In line with this reasoning, Oosterhof and Todorov (2008) demonstrated that face perception can be derived from two dimensions, trustworthiness and dominance, that signal whether the perceiver should interact or not with a person and whether this perceived person can implement his/her intentions.

My proposal is to apply the two notions of embodiment identified above to the dimensions of dominance and trustworthiness. The thesis will implement this mainly for dominance, spanning

Chapters 2 – 6, and only provide a first test of the same idea for trustworthiness in the final empirical Chapter 7.

I will start with the notion that important concepts can be traced back to physical interactions. In the case of dominance, this will imply that dominance can be traced back to the role of bodily strength in social interactions. Next, I will continue with the notion of modal representations, which imply that performed behavior feeds back and influences cognition and mental representation. In the case of dominance, this will imply that behaviors typically associated with dominance, like expanded postures, feed back to cognition about others and the self.

After testing these ideas for dominance, I will also provide a first test of the same argument for the other important dimension of face perception and impression formation, namely trustworthiness. There, the second notion of embodiment, the role of modal representations for social concepts, will be tested. In particular, I will investigate whether experiences of synchrony, a behavior and experience uniquely associated with close relations and self-other merging (e.g. Tsakiris, 2008; Paladino et al., 2010); will impact judgments of trustworthiness through changing mental representations of the self.

My thesis has a greater emphasis on dominance than on trustworthiness. The main reason for this, is related with the fact that the embodiment literature has consistently shown evidence about the role of bodily actions in power relations (e.g. Carney, Cuddy, & Yap, 2010; Huang, Galinsky, Gruenfeld, & Guillory, 2010; Yap et al., 2013). On the contrary, the support for the embodiment of trustworthiness has been scarcer. Only recently, some studies demonstrated the importance of our bodies' movements to social bonding which might be associated with trustworthiness (e.g. Tsakiris, 2008; Paladino et al., 2010).

Let me begin now a more detailed explanation with the connection of strength and dominance. Oosterhof and Todorov (2008) speculated that the dominance dimension might correspond to "an overgeneralization of perception of facial cues signaling the physical strength/weakness of the person" (Oosterhof & Todorov, 2008, p. 11091). However, the participants in their studies were never asked to judge faces on physical strength. Therefore, the central role, in my thesis, of bodily action will be demonstrated, in the first place, by studying whether the perception of dominance is related to the perception of physical strength. The literature has shown that people can accurately judge physical strength when seeing only the face (Sell, Cosmides, et al., 2009). However, the relationship between judgments of dominance and judgments of physical strength has not been studied. I believe that the perceiver would incur great costs if he/she were unable to quickly identify a physically strong person. During previous periods in human evolution, it is likely that physical strength increased the chances of securing recourses and give benefits to others as well as success in fighting contests (e.g. Von Rueden, Gurven, & Kaplan, 2008). Therefore, physically strong persons would be more socially dominant. The rank in social hierarchies for strong persons would be high. Therefore, I posit that mechanisms to perceive physical strength may have evolved to perceive dominance. In sum, I intend to empirically demonstrate that dominance is related to the perception of the ability to implement intentions through bodily actions (i.e. physical strength, see **Chapters 2, 3 and 4**).

Given that face evaluation is related to a need for action (e.g. Oosterhof & Todorov, 2008), it should actively respond to contextual and dynamic cues (e.g. Zebrowitz, 1997). I intend to show how dominance and physical strength change according to a different context. Impressions from faces should be constantly adapting to the involving social environment - see **Chapter 4**.

As the **Chapters 2 through 4** demonstrate, dominance judgments could be a by-product of overgeneralization of physical strength cues. This mechanism plays an important role given that it allows us to decipher how someone is able to implement his/her intentions which could influence how someone should act. Therefore, perceiving facial dominance may have helped us to act by allowing us to estimate the costs of contesting someone. However, actual actions from our bodies may also influence face evaluation. The importance of our bodies' actions in face perception will be shown in the remaining empirical chapters, through the manipulation of bodily postures (**Chapter 5 and 6**) and the interaction between bodies (**Chapter 7**)

In the present dissertation, my goal is to demonstrate that behavior performed by our bodies is one of the central mechanisms underlying impressions from faces. With the goal of showing the embodiment of face evaluation, I conceived six sets of experimental studies that will be presented in following six chapters.

In the first empirical chapter (**Chapter 2**), I show two experiments that study whether judgments of dominance from faces partly rely on judgments of bodily strength. In two studies, I try to demonstrate such a relation for both computer-generated and natural photos of male faces. My analysis consisted in using data aggregated across participants and hierarchical models.

Moreover, I want to identify common predictors that underlie perceptions of both strength and dominance. In the second empirical chapter (**Chapter 3**) I will present two studies. In the first study, I used a data-driven approach to create statistical face shape models of both judgments of dominance and physical strength (e.g. Todorov, Dotsch, Wigboldus, & Said, 2011). I looked for similarities and differences between the visual representation of physical strength and dominance models. Additionally, I created models of judgments that capture the differences between physical strength and dominance. In this model, I generated faces that vary from dominant, but physically weak, to submissive, but physically strong. In the second study, I validated our models. I asked participants to decide from faces of models of physical strength and dominance judgments whether they are able to distinguish the models of dominance from physical strength (see Todorov et al., 2013).

In the third empirical chapter (**Chapter 4**), I will present five studies where I explored how dominance and physical strength may change when the faces are not shown in the exact same position. I manipulated head position and gaze direction to study the role these variables play in dominance and physical strength judgments from faces. Head position and gaze are related to processes of emotion perception (Adams & Kleck, 2005) and dominance displays (Darwin, 1972; Mignault & Chaudhuri, 2003). I asked the participants to judge faces with three levels of head position (i.e. faces seen from below (+25º), from the front (0º), and from above (-25º) and two types of gaze direction (directed versus averted). I expected that dominance and physical strength will change depending on gaze and head angle position. However, I explored whether both judgments will be interrelated and show a resembling pattern across the levels of head position and gaze direction.

In **Chapter 5,** I present one experiment of how dominance judgments from faces can be changed with bodily manipulations (expanded posture versus constrictive posture). The literature has shown that people attribute more power to themselves when they are in an expanded posture rather than in a constricted posture (e.g. Hall, Coats, & LeBeau, 2005). I asked participants to judge faces on dominance. These faces had three levels of dominance (i.e. very non-dominant, medium dominant, very dominant). I showed that the type of posture may alter participants' judgments and perceived differences of the three levels of dominance.

In the fifth empirical chapter (**Chapter 6**), I will present one experiment using reverse correlation methods (Dotsch, Wigboldus, Langner, & van Knippenberg, 2008; Mangini & Biederman, 2004). This method enabled me to look in more detail at the way the perceiver represents mentally. I used this method to identify whether the posing of a specific bodily posture (expansive versus constrictive) can alter the way we represent our own face. More specifically, I showed that dominance of the self-face can be changed through a bodily manipulation. Therefore, I expect that in an expansive posture the self-face will be judged as more dominant than in a constrictive posture.

In **Chapter 7,** I will come to the other important dimension of face evaluation: trustworthiness. As in the previous studies on dominance, I tested whether producing feedback based on behavior was able to change cognition about the self and others. The relational behavior synchrony took the role that postures played on dominance. The present two experiments based on the notion of the *enfacement effect* (Paladino, Mazzurega, Pavani, & Schubert, 2010; Sforza, Bufalari, Haggard, & Aglioti, 2010; Tsakiris, 2008). This chapter tries to show how the interaction of our bodies with someone else's body might influence face evaluation. This effect occurs when experiencing a synchronous stimulation of one's cheek while seeing someone else's face being touched in a synchronous way. Another person's face being stroked by a brush is presented on a screen while the participant's face is stroked in synchrony or asynchrony. This typically leads to cognitive and social-cognitive effects resembling self-other merging. My goal is to know whether the effects of synchronous stimulation go beyond such relational effects, and can also impact judgments of facial appearance, namely trustworthiness. In two studies, I intend to demonstrate that this multisensory stimulation may change the evaluation of faces. In the first study, participants judged how trustworthy the faces are. I tested whether in a synchronous stimulation the faces are judged as more trustworthy than in the asynchronous condition. In the second study, I looked whether a synchronous stimulation may bias the participants to remember the other's face as more trustworthy, compared to an asynchronously stimulated target.

In the next six chapters, I will report my empirical studies. Each chapter corresponds to an article that was either published or submitted. After these empirical chapters, I will have a final chapter where I integrate and discuss my findings. In this last chapter, I also intend to show the overall contributions of my work to face evaluation literature.

CHAPTER II[1]

JUDGMENTS OF DOMINANCE FROM THE FACE TRACK PHYSICAL STRENGTH

One basic type of human social relationship is based on social hierarchies with some individuals having greater access to resources and more control than others (Fiske, 1992). Similar, but much more rigid social hierarchies occur in the species most closely related to us, chimpanzees, bonobos, and gorillas (Smuts, 1987). Social hierarchies of larger groups of humans are evident at least from the point at which chiefdoms were developed, and have been prevalent in human societies ever since (Boehm, 1999).

An individual who maintains a high rank in social hierarchies is referred to as *dominant*. High rank can be the outcome of various determinants; one likely determinant is bodily strength, important both to secure resources and prevail in dominance contests. In line with other recent arguments (e.g. Fink, Neave, & Seydel, 2007; Sell, Tooby, & Cosmides, 2009; Windhager, Schaefer, & Fink, 2011), here we provide evidence for the idea that judgments of dominance partly rely on judgments of bodily strength.

2.1 Facial Maturity and Dominance

Theories of interpersonal relations, perception and judgment have long considered *dominance* as a central trait (Wiggins, 1979). For example, in the interpersonal circumplex model, the vertical axis of personality is dominance vs. submissiveness, with the second axis being cold vs. warm (Wiggins, Phillips, & Trapnell, 1989). When people perceive another individual, that individual is automatically categorized according to sex and age (Kurzban, Tooby, & Cosmides, 2001), but it is also judged spontaneously in terms of personality traits. Dominance is one of the

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[1] This chapter is based on the paper Toscano, H., Schubert, T. W., & Sell, A. N. (2014). Judgments of dominance from the face track physical strength. *Evolutionary Psychology*, *12*, 1-18.

two central traits judged from perceiving a human face. For instance, Oosterhof and Todorov (2008) used a series of principal component analyses to identify the dimensions underlying face evaluation. In a bottom up approach, they started with more than 1000 trait inferences from faces, narrowed them down to 15 traits, and collected ratings of these traits, which were then analyzed. They found two dimensions that accounted together for more than 80% of the variance of trait judgments from faces. One of the dimensions was dominance, the other trustworthiness. The judgments of the traits dominant, mean, aggressive and confident were the closest to the axis of the factor, with the trait dominant the most central. These findings led the authors to consider dominance as one of the dimensions of face evaluation.

Facial dominance correlates with social outcomes. Muller and Mazur (1997) found that West Point cadets with more dominant faces were more likely to attain higher ranks in their career. The influence of dominance can also be seen in the courtroom, where plaintiffs with more mature looking faces receive higher penalties than baby-face looking ones (Zebrowitz & McDonald, 1991). Facial dominance also predicts election outcomes (Chiao, Bowman, & Gill, 2008; Little et al., 2007; Rule et al., 2010).

2.2 Dominance and Strength

Social dominance is determined partly by actual physical strength, which predicts a man's rank in the social hierarchy in general (Von Rueden, Gurven, & Kaplan, 2008). The notion of social dominance is usually characterized as a superior likelihood in competitive contests of attaining the access to assets. Status is related with our chances of surviving, reproduction and kin protection (Cummins, 2005). Puts (2010), while discussing the mechanisms of sexual selection, posited that contests between men can be their central process of sexual selection. According to him, typically male features such as a larger body, more muscularity and physically strength are related to males' evolutionary history of fighting and competition. Thus, individuals with more strength have a higher resource-hold potential or formidability (Parker, 1974). It is plausible that formidability contributes to status both because of advantages in inter-individual contests for higher ranks and also because it secures resources in contests with competitors outside of the hierarchy. Additionally, men with a higher ability to inflict harm on others have a higher fertility, which is related to social status (e.g. Von Rueden, Gurven, & Kaplan, 2011).

This reasoning suggests that mechanisms we evolved to perceive physical strength routinely contribute to the formation of social hierarchies, that is, dominance. Indeed, it would be zoologically unusual if it were not the case (Smuts et al., 1987).

What is the evidence for this assumption? Some insights come from research on the baby face overgeneralization hypothesis. In general, this research tradition assumes that a number of traits are associated with individuals who are either very high or very low in babyfacedness, such as social submissiveness vs. dominance, social dependency vs. autonomy, physical weakness vs. strength, and so on. This line of work has referenced bodily strength, but it has rarely focused on it specifically.

For instance, Zebrowitz and Montepare (1992) investigated correlations between ratings of babyfacedness and ratings of physical weakness (among other variables). The two variables correlated for both male and female targets of all age groups after infancy, and judgments of physical weakness also correlated with the composite variables reflecting actual babyfacedness of the judged faces.

More recently, using handgrip strength as a proxy of human physical strength (Rantanen et al., 1999, Wind et al., 2010), Fink, Neave and Seydel (2007) showed that women's ratings of men's dominance and masculinity based on faces correlated with those men's actual handgrip strength. Gallup et al. (2010) also found that handgrip strength was positively correlated with self-ratings of dominance and aggression. Similarly, participants with more upper-body strength reported more aggressive behavior and entitlement (Sell, Tooby, et al., 2009). However, they do not show exactly relations between judgments of strength and dominance based on face.

Supporting evidence also comes from findings that dominance and strength judgments are determined by the same variables. For instance, Jones et al. (2010) created masculinized and feminized versions of target faces. Participants then judged the dominance and physical strength of those target persons. The masculinized versions were judged as both more dominant and physically strong.

Oosterhof and Todorov (2008), using a data driven statistical model (Blanz & Vetter, 1999; Facegen Main Software Development, 2006), rendered computer-generated faces varying along the dominance continuum and found that faces tended to be more mature and masculine in the positive extreme of the dominance axis. They assumed that dominance dimension was "an overgeneralization of perception of facial cues signaling the physical strength/weakness of the person" (p. 11091). Nonetheless, these participants were never asked to judge how physically strong they thought the faces were.

Sell, Cosmides, et al. (2009) arrived at a similar idea. They tested what cues people use to accurately judge the actual strength of a person. The targets in their study were actually tested for their objective strength through weight-lifting tasks. Observers' judgments of physical strength correlated with the actual strength of these targets, both when they saw the whole body, and also when they only saw the face.

Thus, the idea that bodily strength underlies dominance ratings follows from an analysis of the determinants of social dominance, has been prominently featured in arguments on both facial dominance and judgments of strength, and is in line with previous findings of the relation of judgments to actual physical strength. Here, we test directly whether judgments of physically strength are related to judgments of dominance when participants only see faces. Furthermore, we will take a variety of correlational approaches, including tests for correlations when the judgments of dominance and physical strength are coming from different participants.

2.3 Facial Features of Dominance and Strength

In addition, we take a closer look at the facial features underlying such a correlation. We explore if there are common facial predictors for both strength and dominance. Zebrowitz (1997) showed that a babyface has large eyes, high eyebrows, small chin, round jaw, and high forehead. A face judged as dominant typically features small eyes, low brows, large chin, a more angular face and a low forehead (see also Keating, 1985; Lorenz, 1943). Studies of sexual dimorphism (e.g., Penton-Voak et al., 2001) reveal that males have a bigger jaw, and a more prominent brow ridge and cheekbones. Because masculinity can signal dominance (Mueller & Mazur, 1997), more dominant faces share those characteristics. Schaefer et al. (2009) demonstrated that men's facial shape related to prenatal levels of testosterone was very similar to the facial shape that emerged from women's ratings of masculinity and dominance. More recently, Windhager, Schaeffer and Fink (2011) found that men's faces that were considered more dominant by women were more similar to physically strong faces. Using handgrip strength as a general measure of strength and with the help of a geometric morphometric (GMM) toolkit (e.g. Mitteroecker and Gunz, 2009), they were able to create a facial shape of men's strength. After that, they asked to women to judge men's dominance. These researchers found that the dominant facial shape created on the basis of women's judgments resembled the physically strong facial shape. They found that faces considered more dominant by women and faces from men with a stronger handgrip had shorter noses, thinner lips and wider middle and lower faces. It remains to be seen using both judgments of perceived physically strength and perceived dominance by the participants, if there are common facial features that can predict both judged physical strength and dominance.

2.4 Overview of the Current Research

In the current article, we present two studies. We test whether perceived physical strength is related to dominance judgments from the face. In addition, we explore which facial features are common predictors of both perceived strength and perceived dominance.

In Study 1, we used computer-generated faces (dimensions 400 x 400) from the set developed by Oosterhof and Todorov (2008). In the Study 2, we used a set of photos (dimensions 337 x 400) of male faces assembled by Sell, Cosmides, et al. (2009).[2]

We collected judgments of strength and dominance for all pictures from both datasets, and in addition measured all faces according to the dimensions described by Zebrowitz, Kikuchi, and Fellous (2007).

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[2] The faces used in our studies show some deviations from the Frankfort Horizontal which can limit the scope of interpretation of our facial measurements (see Schneider, Hecht, Carbon (2012).

2.5 Materials and Methods

2.5.1 Method of Both Studies

2.5.1.1 Procedure

Data for both studies were collected online, using Qualtrics (www.qualtrics.com), and recruiting participants through Amazon Mturk (Buhrmester, Kwang, & Gosling, 2011). Participants were informed that the faces would appear twice with different questions, but the second question was not revealed until all judgments on the first question were completed. Participants were told there were no right or wrong answers and to answer intuitively.

Participants first judged all pictures on one of the dimensions (strength or dominance), and then all pictures again on the other dimension. The order of the two blocks was counterbalanced, and the order of pictures within a block was randomized.

The faces were presented at the center of the screen with the question below. The questions read "How physically strong is this person?" or “How dominant is this person?”, for the two dependent variables, with response scales from 1 to 7 presented below the question, anchored with “very weak” and “very strong”, or “not at all dominant” and “very dominant”, respectively.

Before the dominance block, we explained that by dominance we meant "how much this person wants to influence other people and how much she or he is able to do so”.[3] For strength, no such explanation was deemed necessary.

2.5.1.2 Facial Metrics

We measured the facial features with a procedure based on the one used in Zebrowitz et al. (2007). Each face was loaded in to software developed by us using Processing (http://processing.org/). In this software, 40 facial points were marked (see example **Figure 2.1**) in all faces. These points were all marked independently for all pictures by three research assistants. All distances used by Zebrowitz were used, and two more were added (Z1 and Z2). All measures were normalized by the inter-pupil distance (E2) (see details of measurement in

[3] In this broad definition we thus include both potential and motivation for influence. Influence is a key aspect of social ranking/status (e.g., Cheng et al. 2013).

Zebrowitz et al., 2007).[4] We had 24 facial distance measures in total (see **Figure 2.1**). One of These was the normalization distance (E2), and one was the composite distance Facial Roundness. The other measures corresponded to facial features of the brows, eyes, cheekbones, nose, chin, and head length. More specifically, we measured the inner eyebrows distance (B1), distances related with brow height (B2 to B6), the distance between the inner corners of eyes (E1), distance between the outer corners of eyes (E3), eye width (E4), eye length (E5), nose width (N2) and nose length (N3), the head length (L0), length of the jowl (S0), distance from the pupil to the center of the chin (C1), chin length (C3), mouth width (M0), philtrum length (M3), thickness of the upper lip (M4), lower facial width (W1), head width (W4), cheekbones width (W6), the Z2 thickness of the lower lip (Z2) and the length from the beginning of the hair until the end of the head (Z1).

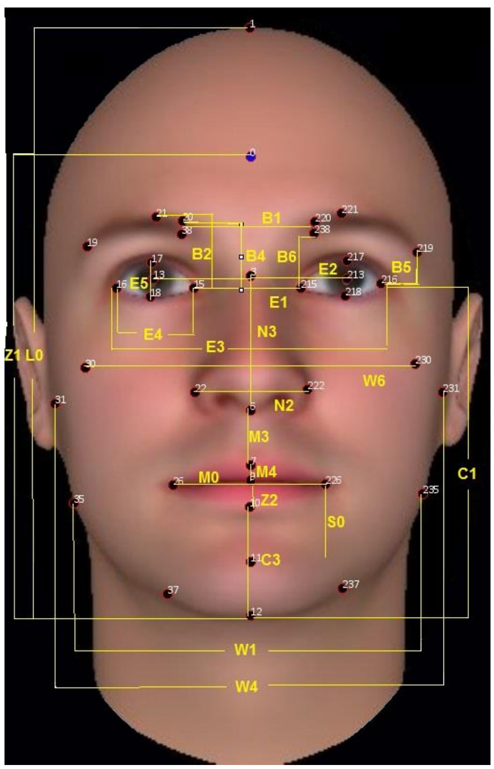

Figure 2.1: Measurement of Facial Metrics through marking of 40 reference points

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[4] It should be referred that this standardization through the inter-pupil distance is not able to erase the size cues from the faces. Because of the importance of height cues in judgments of human face (e.g. DeBruine, Jones, & Perrett, 2013) we recognize that this may influence the judgments of our participants.

There was a high inter-rater reliability for all facial measures. The measurements showed a high agreement for the normalization distance (E2) for both Study 1 (α = .98) and Study 2 (α = .99). The average interrater reliability for all facial metrics showed a strong agreement for the Study 1 database faces (α = .85) and for Study 2 faces (α = .93) - see **Table 2.1**. We then averaged across the three raters all the facial distances measured and used these means in all following analyses.

Table 2.1: Average Inter-rater Reliability of Facial Features for Face Database of Studies 1 and 2

Feature	Study 1	Study 2
B1	.72***	.90**
B2	.97***	.99*
B4	.92***	.99***
B5	.67***	.97***
B6	.96***	.92***
E1	.92***	.96***
E3	.97***	.94***
E4	.89***	.89***
E5	.83***	.97***
N2	.95***	.99***
N3	.82***	.96***
M0	.95***	.84***
M3	.89***	.94***
M4	.69***	.97***
S0	.65***	.95***
C1	.93***	.99***
C3	.93***	.98***
W1	.98***	.59***
W4	.97***	.96***
W6	.68***	.90***
L0	.96***	.97***
Z1	.52***	.91***
Z2	.84***	.97***
Facial Roundness	.75***	.81***

*** $p < .001$

2.6 Study 1

2.6.1 Participants

We recruited 69 participants (41 female) from the United States of America (USA) and Western Europe through MTurk and paid each $0.50. The mean age was 34.5 (*SD* = 13.99, range 18 to 77).

2.6.2 Materials

Participants judged 60 computer-generated faces developed by Oosterhof and Todorov (2008, see **Figure 2.2**). The pictures were created with FaceGen software (Facegen Modeller program version 3.1, http://facegen.com). The rendered pictures show heads of mostly White faces of both genders (for some faces, gender and ethnicity is hard to judge) without hair or clothing.

Figure 2.2: Examples for the Stimuli in Study 1 (Database developed by Oosterhof & Todorov, 2008)

2.7 Results

We used Linear Mixed Models (also known as hierarchical linear modeling) to analyze the relation between ratings of strength and ratings of dominance, and the mediation of this relation by facial features. For the mixed models, the units of analysis were the single judgments made by the participants regarding dominance. Both picture and participant were added as groupings of the observations. For both pictures and participants, the intercepts were allowed to vary randomly. The dependent variable was ratings of dominance.

In the first model, we introduced ratings of strength, order of ratings (strength first vs. dominance first), gender of participant, and their interactions as independent and fixed factors. We estimated this model with the Mixed procedure in SPSS 18. The strength and dominance ratings were z-standardized (based on grand mean) prior to analysis. This model showed that perceived strength was a significant predictor of perceived dominance, F (1, 3933.14) = 247.89, $\beta = .26$, $p < .001$. Gender had no effect, $F(1,61.94) = 0.10$, $p = .76$, and neither did order of judgment, $F(1, 61.90) = 0.64$, $p = .53$. There was no interaction between gender and order, $F(1, 61.92) = 0.15$, $p = .86$.

It could be possible that the second judgment assimilated to the first judgment. In order to check for this possibility, we needed to resort to aggregated values. We aggregated ratings of dominance and strength for each picture across participants, thereby creating a dataset where the single pictures were the units of analysis. Note that aggregation across so many observers reduces error variance, resulting in higher correlations overall. After that, we standardized the dominance and strength judgments. We did Pearson correlations between ratings of strength and ratings of dominance. A first correlation was computed using both judgments participants gave, with each picture as the unit of analysis. The correlation was very high, $r = .95$, $p < .001$. We then repeated this analysis using only the first answer each participant gave for the aggregation. The correlation obtained was about the same, $r = .94$, $p < .001$. This indicates that, for this sample, a face that was perceived – on average – to be dominant was also perceived to be strong (see **Figure 2.3**), even when both judgments came from different participants who did not judge the other dimension first.

We then tested which facial features predicted judgments of dominance and strength. For this, we ran two models. In the first, dominance was the dependent variable, and all facial features were added as independent variables. Pictures and participants were again added as groupings, letting the intercepts vary randomly across both. The second model was the same except that strength was the dependent variable. We then identified which predictors were significant in both models.

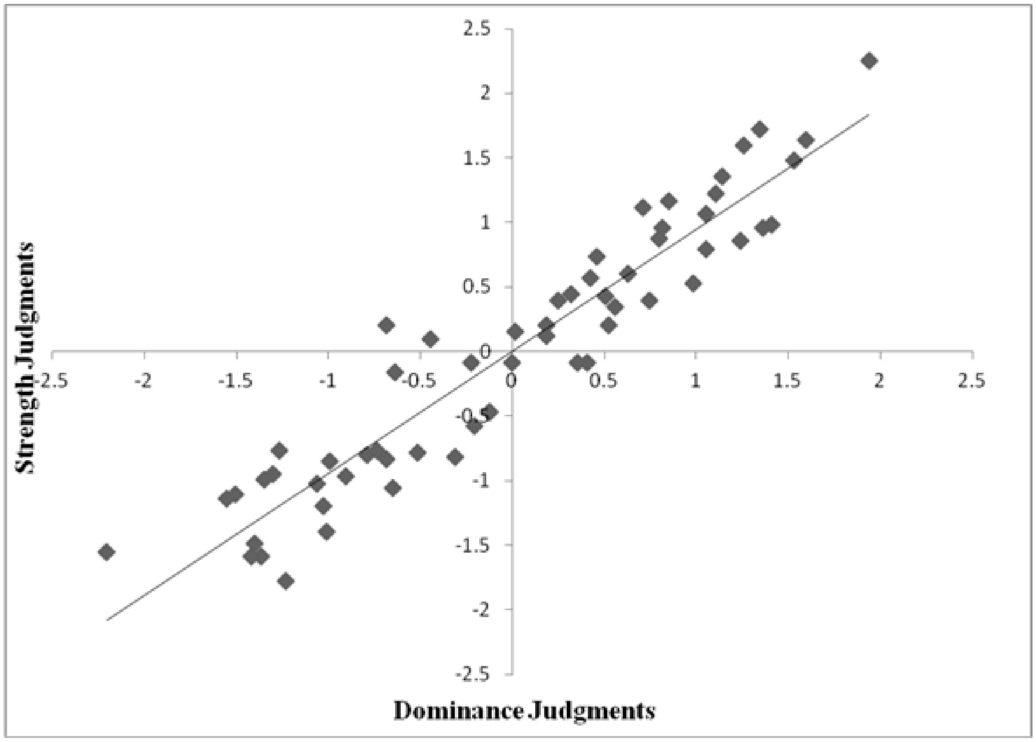

Figure 2.3: Scatter plots of z-standardized mean judgments of strength and mean judgments of dominance

In the outcomes of these models, we identified facial characteristics that predicted both dominance and strength (see **Table 2.2**). There were three: brow height (negatively, β = -0.51, p = .006 for dominance and β = -0.40, p = .037 for strength, B6), eye length (negatively, β = -0.25, p = .011 for dominance and β = -0.26, p = .013 for strength, E5), and nose width (positively, β = 0.15, p = .005 for dominance and β = 0.14, p = .013 for strength, N2). In addition, mouth width (M0) marginally (negatively) predicted dominance (β = -0.09, p = .078) and strength (β = -0.09, p = .106). In sum, a person with a wide nose, narrow (vertically) eyes, low brows and a narrow mouth is simultaneously seen as strong and dominant. There was one facial feature - head width - that only predicted dominance (negatively, β = -0.34, p = .04 for dominance and β = -0.17, p = .338 for strength, W4). There was not any facial feature that predicted strength but not dominance (Table 2).

Table 2.2: Facial Features relation with Dominance and Physically Strength Judgments - Study 1

	Study 1							
	Dominance				Strength			
Feature	β	*P*	95% CI low	95% CI up	β	*p*	95% CI low	95% CI up
B1	0.02	.786	-0.10	0.13	0.04	.516	-0.09	0.17
B2	0.08	.532	-0.19	0.36	0.02	.915	-0.28	0.31
B4	0.22	.310	-0.21	0.64	0.20	.381	-0.26	0.66
B5	0.06	.368	-0.08	0.21	0.07	.377	-0.09	0.23
B6	-0.51	.006	-0.86	-0.16	-0.40	.037	-0.78	-0.03
E1	1.39	.110	-0.33	3.10	0.12	.901	-1.74	1.97
E3	-1.58	.118	-3.58	0.42	-0.20	.852	-2.36	1.97
E4	2.54	.104	-0.55	5.62	0.31	.853	-3.03	3.64
E5	-0.25	.011	-0.43	-0.06	-0.26	.013	-0.46	-0.06
N2	0.15	.005	0.05	0.25	0.14	.013	0.03	0.25
N3	-0.16	.234	-0.44	0.11	-0.01	.968	-0.30	0.29
M0	-0.09	.078	-0.19	0.01	-0.09	.106	-0.20	0.02
M3	0.09	.323	-0.09	0.27	0.04	.649	-0.15	0.24
M4	-0.04	.549	-0.19	0.10	-0.04	.604	-0.20	0.12
S0	-0.15	.332	-0.45	0.16	-0.09	.594	-0.41	0.24
C1	-0.23	.480	-0.89	0.43	0.31	.388	-0.41	1.02
C3	0.17	.380	-0.22	0.57	0.13	.556	-0.30	0.55
W1	0.06	.577	-0.15	0.26	0.17	.125	-0.05	0.39
W4	-0.34	.040	-0.67	-0.02	-0.17	.338	-0.53	0.19
W6	0.01	.887	-0.16	0.19	-0.03	.767	-0.22	0.16
L0	0.28	.350	-0.32	0.88	-0.15	.650	-0.80	0.50
Z1	-0.08	.560	-0.34	0.19	-0.13	.378	-0.41	0.16
Z2	0.02	.771	-0.12	0.16	0.11	.159	-0.04	0.26
FRoundness	0.30	.086	-0.04	0.64	0.05	.780	-0.32	0.42

2.8 Discussion

In Study 1, when participants judged computer-generated faces, perceptions of strength and ratings of dominance were closely related, as shown both in the mixed model analysis and in the correlations based on aggregated values. Importantly, this was also the case when those ratings came from different participants (always using the first rating). Order of ratings and gender of participants did not make any difference.

Our analysis of facial features identified a wide nose, short (vertically) eyes, low brows, and a narrow mouth as common predictors of strength and dominance. A less wide head predicted dominance but not strength.

One problem with the second step of our analysis is that we investigated a large number of predictors simultaneously in the multilevel models. This has the potential to create false positives through accumulated alpha error. These results should thus be interpreted as exploratory and subject to replication. Study 2 aims at providing such a replication. There, we will jointly consider significance and inclusion in confidence intervals as criteria for replication.

2.9 Study 2

Study 2 was conducted to replicate the findings from Study 1 with photos of real faces instead of computer-generated pictures.

2.10 Method

2.10.1 Participants

We recruited and paid 135 (78 female) participants from the United States of America and Western Europe as in Study 1. The mean age was 35.61 (*SD* = 11.87, range 18-66).

2.10.2 Materials

We used 62 photos of male faces (mean age: 21.1, *SD* = 2.4, range 18–32; 62% Euro-American, 15% Asian-American, 5% African-American, 2% Middle Eastern, 5% Hispanic, 11% other, with no significant differences in strength as a function of ethnicity) assembled by Sell, Cosmides, et al. (2009, see **Figure 2.4**).

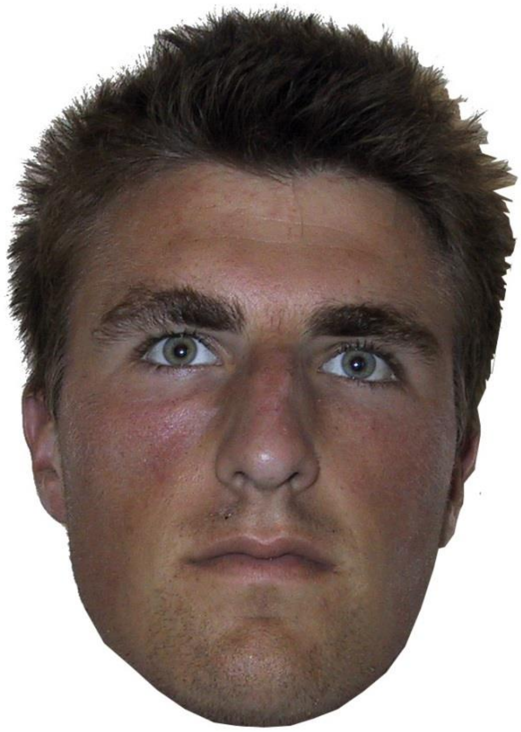

Figure 2.4: Example of the Stimuli in Study 2 (Database developed by Sell, Cosmides, et al., 2009)

2.11 Results

We again set up a mixed model, predicting ratings of dominance from ratings of strength , adding participant gender as a fixed factor, and both participant and picture as grouping variables, allowing the intercepts to vary across them. Judgments of strength predicted judgments of dominance, F (1, 8268.304) = 718.44, $\beta = 0.29$, $p < .001$. Gender had no effect, $F(1, 132.85) = 0.205$, $p = .652$.

Because of a software failure in Qualtrics, order of scales was not recorded. Note however that order had no effect in Study 1.

We then proceeded by creating aggregate scores, averaging ratings of strength and dominance across participants. We standardized these judgments and did Pearson correlations. The correlations of these two aggregated variables was somewhat lower than for artificial faces, though still quite high, $r = .78$, $p < .001$.

We also analyzed whether judgments in our study were related to the actual upper body-strength of the judged targets (targets were assessed on weight lifting machines; see details in Sell, Cosmides, et al., 2009). We used the aggregated values for these analyses for the Pearson correlations. Actual upper body strength was correlated both with judgments of strength ($r = .54$, $p < .001$) and the judgments of dominance ($r = .34$, $p < .001$). In other words, men with objectively stronger upper bodies are judged as stronger and as more dominant purely relying on facial characteristics. To tease these relations apart, we computed partial correlations. When controlling for dominance judgments, the partial correlation between judged strength and actual strength remained significant, $r = .46$, $p <.001$. However, when controlling for judgments of strength, the partial correlation between dominance and the actual strength was not significant $r = -.14$, $p = .308$.

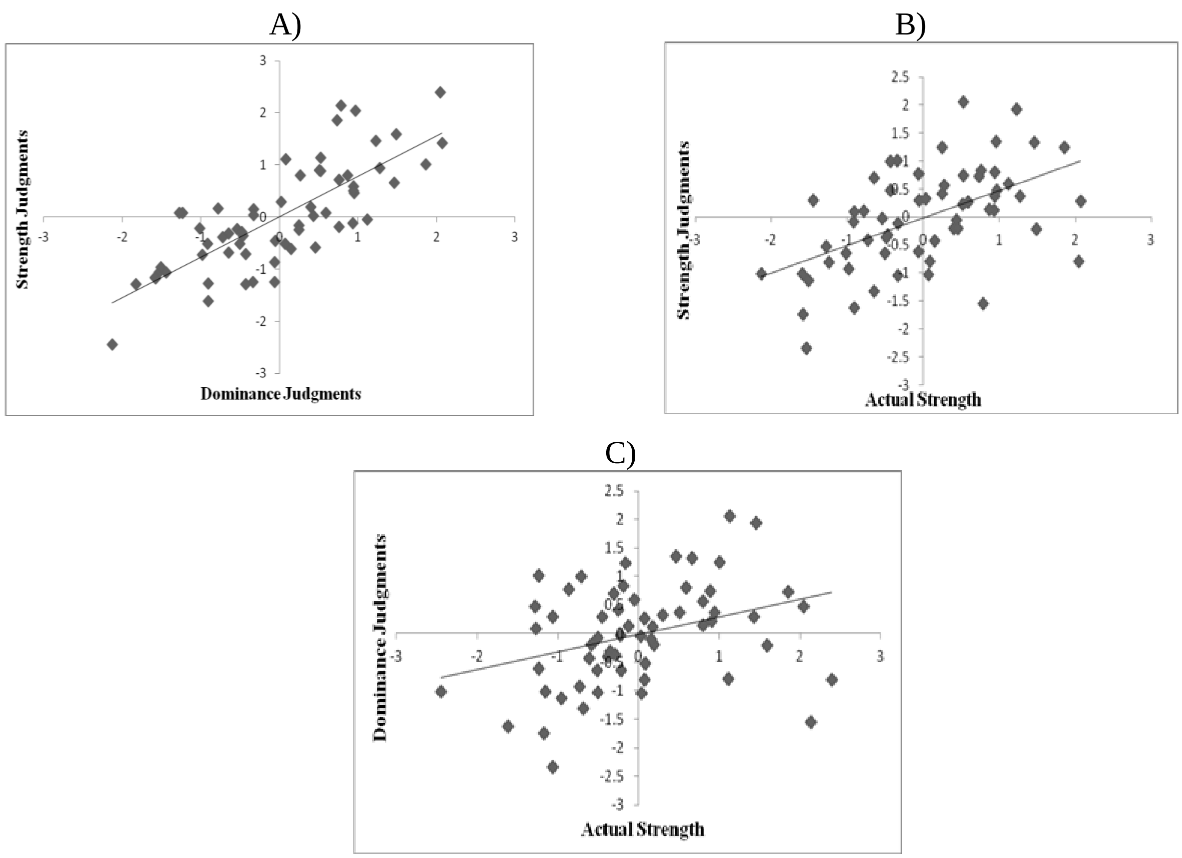

Figure 2.5*:* A) Scatter plot of *z*-standardized mean judgments of strength and mean judgments of dominance; B) Scatter plot of *z*-standardized mean judgments of strength and actual strength; C) Scatter plot of *z*-standardized mean judgments of dominance and actual strength

We then repeated the analyses performed in Study 1 to determine which facial features predict both strength and dominance (see Table 2). We found fewer common predictors than in Study 1. Brow height (B6) predicted dominance significantly (negatively), β = -0.38, p = .004 and strength marginally, β = -0.26, p = .072. Eye length (E5) predicted marginally both dominance (also negatively), β = -0.19, p = .071 and β = -0.22, p = .079 strength. Finally, chin length (C3) predicted (positively) dominance, β = 0.58, p = .024 and marginally predicted strength, β = 0.54, p = .061. In sum, a man featuring low brows, (vertically) narrow eyes, and large chin will be judged as both strong and dominant.

We found facial features that predicted dominance but not strength and vice versa. Nose length (N3) predicted dominance significantly (positively), β = 0.26, p = .05 but not strength, β = 0.11, p = .484. Distance from the pupil to the center of the chin (C1) predicted dominance significantly (negatively), β = -0.54, p = .002 but not strength, β = -0.28, p = .156. Brow height (B2) marginally predicted strength (positively), β = 0.55, p = .052 but not dominance, β = 0.30, p = .207.

However, the facial features of nose width (N2) and mouth width (M0) that predicted both dominance and strength in Study 1, did not show the same pattern in Study 2. Nose width (N2) did not predict dominance β = 0.10, p = .253 and strength, β = 0.10, p = .333. Finally, mouth width (M0) marginally predicted dominance (negatively), β = -0.12, p = .081, but did not predict strength, β = 0.04, p = .565.

Nonetheless, the β-values for the nose width (dominance: β = 0.10; strength: β = 0.10) are within the Study 1 confidence intervals for dominance [0.05;0.25] and physical strength [0.03;0.25]. Consequently, it is likely that Study 1 overestimated the strength of this cue, but that this cue is still important. The estimates of mouth width (M0, dominance β = -0.12; strength: β = 0.04) fall within the limits of the confidence intervals of Study 1 only for dominance judgments [-0.19;0.01], but not for physical strength judgments [-0.20;0.02]. Thus, Study 2 contradicts Study 1 here, and M0 is likely not used as a cue to physical strength, but only used as a cue for dominance (see **Table 2.3**).

Table 2.3: Facial Features relation with Dominance and Physically Strength Judgments - Study 2

	Study 2							
	Dominance				Strength			
Feature	B	*P*	95% CI low	95% CI up	B	*P*	95% CI low	95% CI up
B1	0.09	.271	-0.07	0.24	0.10	.255	-0.08	0.28
B2	0.30	.207	-0.17	0.78	0.55	.052	0.00	1.10
B4	-0.19	.456	-0.71	0.33	-0.54	.076	-1.14	0.06
B5	0.08	.357	-0.10	0.27	0.05	.613	-0.16	0.27
B6	-0.38	.004	-0.62	-0.13	-0.26	.072	-0.55	0.02
E1	-1.09	.216	-2.83	0.66	-1.40	.167	-3.41	0.61
E3	1.39	.217	-0.85	3.64	1.68	.197	-0.91	4.27
E4	-2.11	.238	-5.68	1.46	-2.60	.208	-6.71	1.51
E5	-0.19	.071	-0.40	0.02	-0.22	.079	-0.46	0.03
N2	0.10	.253	-0.07	0.27	0.10	.333	-0.10	0.29
N3	0.26	.050	0.00	0.52	0.11	.484	-0.20	0.41
M0	-0.12	.081	-0.25	0.02	0.04	.565	-0.11	0.20
M3	0.15	.095	-0.03	0.32	0.04	.707	-0.16	0.24
M4	0.07	.524	-0.14	0.27	-0.01	.902	-0.25	0.22
S0	-0.15	.489	-0.59	0.29	-0.23	.353	-0.74	0.27
C1	-0.54	.002	-0.88	-0.21	-0.28	.156	-0.67	0.11
C3	0.58	.024	0.08	1.07	0.54	.061	-0.03	1.11
W1	0.09	.511	-0.18	0.35	0.25	.103	-0.05	0.55
W4	0.01	.939	-0.35	0.38	-0.12	.571	-0.54	0.30
W6	-0.08	.520	-0.34	0.17	-0.08	.597	-0.37	0.22
L0	0.00	.970	-0.24	0.25	-0.09	.537	-0.37	0.20
Z1	0.33	.125	-0.10	0.75	0.40	.105	-0.09	0.89
Z2	-0.01	.912	-0.22	0.20	-0.04	.723	-0.28	0.20
FRoundness	0.08	.439	-0.13	0.29	0.16	.181	-0.08	0.41

2.12 General Discussion

In this chapter, we demonstrate a relation between perceived strength and perceived dominance for both computer-generated faces (Study 1) and photos of male faces (Study 2). In both studies, using multilevel modeling, we found that judgments of dominance were predicted by judgments of strength. When aggregating data across participants, and taking picture as the unit of analysis, the correlation is larger than .90 for computer-generated faces and larger than .70 for real faces. Importantly, this correlation remains unchanged when the strength and dominance were judged by different raters.

It is notable that the correlation between aggregated values of strength and dominance is lower for the natural photos in Study 2 than for the computer-generated in Study 1. (Note that Matheson and McMullen, 2011, showed that computer-generated faces have the same perceptual and memory processing as natural faces). This could be the result of some real targets not having perfectly neutral expressions, or not being uniformly bald, and thereby providing other cues of dominance along with the cues related to strength alone (e.g. perhaps cues of hostility). However, it should be noted that the coefficients in the mixed model did not differ substantially from each other.

For the targets judged in Study 2, we had measurements of their actual upper-body strength. Our data show that both the judgments of strength and dominance were related to actual strength. In other words, it is not only the case that dominance judgments are related to strength judgments, but also to actual strength. Thus, it seems that (accurately judged) actual strength might serve as a cue to dominance. Even though in typical Western social environments social status between adults is rarely negotiated based on physical strength except in sports contests, both males and females base their dominance judgments partly on facial cues of strength.

However, the modest correlation between dominance judgments and actual strength and also the finding that the relation between dominance and actual strength become non-significant when controlling for judged strength suggest that perceivers use other cues to judge dominance as well. During human evolution, bodily strength was an important basic heuristic for social status given that it predicted the ability to apply intentions. Nonetheless, the mental skills associated with leadership, the ability to solve problems and material possessions would also be important for a higher social dominance because of their likelihood of increasing the ability to give benefits to others. Thus, not only the increasing ability to win physical contests (i.e. greater physical strength), but also a greater influence in the community through the benefits that they are able to confer to the general population suggest that both processes can be avenues to the perception of social dominance. In tribal societies we can see that, for example, hunting skills, knowledge about migration cycles of animals, and being elderly are linked to a higher social status. In industrial societies social status is probably even less related to physical strength and more associated with intelligence, social skills and technological expertise (Cheng et al., 2013; Henrich & Gil-White, 2001; Von Rueden, Gurven, & Kaplan, 2011).

Going beyond the identification of a relation between strength and dominance, we identified common cues that may enable the assessment of strength and dominance. Nonetheless, for the natural faces the common predictors of high dominance and strength ratings were low brows (B6), narrow (vertically) eyes (E5), and large chins (C3). In computer-generated faces, common predictors were low brows (B6), narrow (vertically) eyes (E5), and wide noses and narrow mouths (N2 and M0).

In previous studies, these facial features were already linked with dominance judgments. For instance, the baby face overgeneralization hypothesis (e.g. Zebrowitz, 1997) posits that because babies have certain facial characteristics people will judge persons according to those. Thus if someone has small eyes, large chins and low brows people will tend to see those faces as resembling a mature adult because babies show the opposite pattern. Curiously, Dotsch and Todorov (2012) used a reverse correlation method with natural faces and revealed that the most diagnostic facial cues of dominance were the regions around the eyes and the delineation of the face where they included the chin. Windhager, Schaefer and Fink (2011) showed that the main regions related with perceived dominance were a wide lower face, a short nose and small eyes. Although there were some differences with the facial regions found in our research, these studies give support to the idea that the main regions to track strength are essential to track dominance. We recognize that our method of identifying these facial features shows some limitations. Because faces are processed in a holistic way, that is, people tend to perceive and judge faces as a whole and not as an identity of separated and independent features, this process of measuring multiple facial distances between landmark points in space tend to ignore the general facial shape (Holland, 2009).

It is important to add that our data by no means suggest that judgments of social dominance and judgments of bodily strength are the same. As the study of Windhager, Schaefer and Fink (2011) revealed, strong faces and dominant faces are not identical. In their research, they were able to show that strong and dominant facial shapes showed differences in certain facial regions like the eyes, the eyebrows, the mouth, the chin, and the region between the eyes and eyebrows. In our study, there were also differences in the facial features predicting dominance and physically strength. More specifically, for the computer-generated faces the head width negatively predicted dominance, but did not predict strength. Moreover, in the natural faces we were able to show that a larger nose and a shorter distance from the pupil to the center of the chin predicted dominance, but not physically strength. Additionally, one of the measures related with the brow height (B2) predicted strength, but not dominance. Besides that, the relation identified in the multilevel model clearly suggests that a substantial part of variance in dominance judgments is not related to bodily strength. It remains a task for future work to investigate where the two dimensions might diverge despite the strong relation we found here.

In sum, we extend the knowledge related with the notion that dominance and strength ratings go hand in hand, even when collecting these data from different participants and when tested on computer-generated and natural faces. The dominance judgments are based on strength ratings, backed up by the findings that the actual bodily strength predicts dominance.

CHAPTER III[5]

PHYSICAL STRENGTH AS CUE TO DOMINANCE: A DATA-DRIVEN APPROACH

People rapidly and involuntarily form impressions about others based on seeing their faces (e.g. Bar, Neta, & Linz, 2006; Willis & Todorov, 2006). In addition to cues of interpersonal warmth, humans seem particularly tuned to features related to dominance (Jones et al. 2010; Oosterhof & Todorov, 2008; Watkins et al., 2010; Watkins, Jones, & DeBruine, 2010). In an analysis of the most frequently inferred personality attributes from faces, dominance emerges as one of the central dimensions of face evaluation (Oosterhof & Todorov, 2008; Sutherland et al. 2013; Todorov, Said, Engell, & Oosterhof, 2008).

Perceptions of dominance affect actions in predictable ways: in times of war, people are more likely to vote for dominant looking politicians (Little et al., 2007); cadets with dominant facial appearance are more likely to reach higher military ranks (Mueller and Mazur, 1996); and dominant looking males have higher reproductive success (Rhodes, Simmons, & Peters, 2005). Looking dominant can also have its pitfalls in contexts involving threat: In the courtroom, more dominant looking defendants receive higher penalties than nondominant looking defendants when plaintiffs are baby-faced (Zebrowitz & McDonald, 1991).

One likely determinant of social dominance is related with cues that signal the ability to apply intentions through bodily actions. Therefore, social dominance is likely to be associated with physical strength because of its importance for prevailing in physical contests as well in securing resources (Sell, Cosmides, et al., 2009; Toscano, Schubert, & Sell, 2014; Windhager, Schaefer, & Fink, 2011). As a result, mental representations of what a dominant face looks like should be similar to mental representations of what the face of a strong person looks like. Here we aim to

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[5] This chapter is based on the paper Toscano, H., Schubert, T. W., Dotsch, R., Falvello, V., & Todorov, A. (2014). *Physical strength as cue to dominance: A data-driven approach*. Manuscript submitted to publication.

demonstrate that the representations of facial dominance and facial strength are indeed *similar* by using a data driven approach (see Todorov, Dotsch, Wigboldus, & Said, 2011). However, because other attributes, such as abilities to build alliances, have long been important for attaining high social dominance (Cheng et al., 2013), we also intend to capture *differences* of mental representations of facial dominance and facial strength. In sum, the goal of this research is to understand similarities of and differences between mental representations of faces of dominant and strong people.

3.1 Dominance and Bodily Strength

According to some authors (Von Rueden, Gurven, & Kaplan, 2008) actual social dominance may have been, in part, derived from actual physical strength over a considerable time of our evolutionary past. In contexts of repeated intergroup fighting during human evolution (Van Vugt, De Cremer, & Janssen, 2007), physical strength may have played an important role in conflict resolution and building of social hierarchies next to other strategies such as alliances. Puts (2010) posits that fighting contests between men are the central process of sexual selection in the evolutionary history of men. Greater physical strength increases the chances of reproductive success which is itself related to social dominance (Von Rueden, Gurven, & Kaplan, 2011). In our ancestors' time mating chances seemed to be strongly related with physical contests. Stronger persons would have more ability to inflict more harm. Even today, boys are ranked by their peers as more dominant if they are involved in more physical contests (e.g. Pellegrini, 1995). Physical strength is associated with fighting ability (Sell, Cosmides, et al., 2009) which suggests that stronger persons would win more physical fights. Thus, it is plausible to assume that social dominance has been related to actual physical strength.

Of course, in our current social reality, status is not exclusively dependent of physical strength but determined by many other factors (Cheng et al., 2013). However, these arguments suggest that the initial mechanisms that Homo sapiens and its ancestors evolved to infer bodily strength may still contribute to infer dominance (see Smuts et al., 1987). Supporting evidence from Fink, Neave and Seydel (2007) shows that judgments of men's dominance are correlated with the judged men’s actual handgrip strength, indicating that physical strength is recognized from perceiving the body and incorporated into dominance judgments. Gallup, O'Brien, White and Wilson (2010) found high correlations between actual handgrip strength and socially dominant behaviors. Likewise, aggression and entitlement are more likely to be found in stronger persons (Sell, Tooby, & Cosmides, 2009). Some studies also show that high levels of circulating testosterone is correlated with dominance and strength (Penton-Voak & Chen, 2004). Together, this suggests that perceiving strong people to be dominant is a veridical judgment.

In line with this alignment of physical strength and both dominant behaviour and dominance perceptions, past research has identified similarities between facial cues indicating strength and facial cues indicating dominance. Windhager et al. (2011), using handgrip strength as a proxy of actual physical strength (Rantanen et al., 1999; Wind, Takken, Helders, and Engelbert, 2010), derived the facial shape associated with actual strength in men. The derived shape was found to be similar to a shape created from dominance judgments.

Consistent with this, Toscano et al. (2014) found that several facial features predicted both physical strength and dominance judgments, in particular eyebrow height, eye and chin length, and the widths of the nose and the mouth; as a result, individuals who were judged as socially dominant were also judged as physically strong, even if those judgments were made by different perceivers. The facial cues identified in this work align with the fact that testosterone is responsible for a more masculine facial appearance, specifically, by making the brow ridge thicker, widening the face and making the chin larger and squared (e.g. Fink et al., 2005).

In sum, due to an evolutionary history in which strength and social dominance have been aligned and due to a social environment where physically strength continues to be associated with actual social dominance for multiple reasons, humans may hold very similar mental representations of faces of physically strong individuals on the one hand and socially dominant individuals on the other hand.

3.2 Modeling Faces

The attempt to identify specific features to learn more about the similarities of mental representations of social dominance and physical strength may have some disadvantages. For instance, we know that individuals with dominant faces have smaller eyes, larger chins and lower eyebrows. The changes in those features would lead in most cases to different perceptions of dominance. Thus, the feature by feature approach may have some limitations given that is unable to create a complete picture of the perceptual representation of traits in the face. More specifically, all the information that people use to make a specific trait judgment may not be fully discerned.

An alternative approach is to identify the holistic changes in face shape that people use to make a specific trait judgment without explicitly manipulating any features in the face (Dotsch & Todorov, 2012; Jack, Caldara, & Schyns, 2012; Oosterhof & Todorov, 2008; Todorov et al., 2013; Todorov & Oosterhof, 2011; Walker, Jiang, Vetter, & Sczesny, 2011; Walker & Vetter, 2009). In this approach, based on the notion of the face space (Valentine, 1991), each face is represented as a point in a multidimensional shape space (Blanz & Vetter, 1999, 2003). Given that each space is fully determined by a set of coordinates in this statistical space, it is possible to model any trait judgment (see Todorov et al., 2013).

Specifically, trait judgments of a random sample of faces can be predicted by the coordinates of the faces in the statistical face space. The resulting dimension captures the maximal variation that explains the specific judgment. With this approach, we can visualize how a face changes from extremely submissive to extremely dominant. Using this approach, Oosterhof and Todorov (2008) built facial shape models of judgments of trustworthiness, threat and dominance. The set of judgments has been extended recently and a reflectance model of changes in skin and texture have been added (Todorov and Oosterhof, 2011). These models of trait judgments have been validated and shown to capture unique variance specific to each judgment (Todorov et al., 2013).

3.3 Modeling Physical Strength and Dominance in the Human Face

Importantly for the current purposes, this approach allows the statistical separation of even highly correlated dimensions. Trait judgments from faces are highly correlated (Oosterhof and Todorov, 2008). Thus, a person that is considered attractive will also be considered likable. However, with this approach shared variance of trait dimensions can be removed through the subtraction of one dimension from the other. For instance, Todorov et al. (2013) were able to create faces that were trustworthy, but not attractive, and faces that were attractive, but not trustworthy. Following this approach, in the current chapter we created a model that investigates the differences between physical strength and dominance. This works in both directions: We can maximize what differentiates dominance from physical strength and, consequently, visualise identities that are dominant but not strong. Alternatively, we can maximize what differentiates strength from dominance, and visualize identities that are strong, but not dominant.

Despite the correlations between physical strength and perceptions of dominance, it is reasonable to assume that perceptions of dominance cannot be fully explained by perceptions of physical strength. For instance, Toscano et al. (2014) found that the actual strength and perceptions of strength were correlated after controlling for dominance, but dominance judgments and actual strength were not correlated after controlling for physical strength judgments. Moreover, social dominance may have always been and is surely now, in modern democratic societies, determined by factors beyond physical strength, such as cognitive and emotional capabilities (see Henrich & Gil-White, 2001).

With this in mind, methods relying on face-space-based data driven will be useful to disentangle the highly correlated dimensions of social dominance and physical strength. Using these methods will allow us to maximize the differences between dominance and physical strength, and to visualize each without the confound of the other. Furthermore, this will allow us to test in a more valid way whether physical strength is used as a cue for judgments of social dominance.

In sum, our main objective is to use a data-driven approach (Dotsch & Todorov, 2012; Todorov et al., 2013; Todorov & Oosterhof, 2011) to create models of judgments of physical strength and dominance, and then to create a model that differentiates these two models. To the best of our knowledge, strength, in contrast to dominance, has not been modelled in this way before. This will enable us to visualize the similarities and differences between physical strength and dominance.

Additionally, one of advantages of this approach is the ability to generate new identities for each model (see Todorov et al., 2013). We will use male and female identities. We use identities of different gender because facial masculinity is associated with facial dominance (e.g. Jones et al., 2010), and because physical strength and dominance may be judged differently for men and women. According to Sell, Tooby, et al (2009) physical strength is associated with social dominance in men, but not in women.

In Study 1 we will create new identities for both models of judgments. Additionally, we will create a model of the differences between dominance and physical strength. In Study 2, using the identities from Study 1, we will test whether the participants can discriminate judgments of physical strength and judgments of dominance.

3.4 Study 1

We asked participants to judge faces on physical strength and dominance. The judged faces were computer-generated from a face space model. The combination of the face model and the judgments allows modelling the combination of face space dimensions that result in maximal change in each of the two judgments. Second, we created new faces, visualising high and low values of these traits. Moreover, we created a model that correlates positively with physical strength and negatively correlates with dominance - this was called the difference dimension model. Thus, we created three dimensions: dominance, physical strength and difference dimension.

3.5 Method

*3.5.1 Participants***.** In total, 194 participants (99 male, M_{age} = 36.05 years, *SD* = 13.15) from the United States of America and Western Europe were recruited and paid $2 USD through Amazon Mechanical Turk (Buhrmester, Kwang, and Gosling, 2011) for participating in the study.

3.5.2 Materials. The stimuli consisted of 300 computer-generated faces originally developed by Oosterhof and Todorov (2008; see **Figure 3.1**). These faces were created with FaceGen Software (Singular Inversions, Toronto, Canada). The stimuli are mostly White faces of both genders (for some stimuli, gender and ethnicity are hard to judge) without hair, facial hair, or clothing.

3.5.3 Procedure. The data was collected online using Qualtrics (www.qualtrics.com). Participants were asked to judge faces, and instructed to rely on their intuition. On a single trial, one face was presented at the center of the screen with a question below “How physically strong is this person?" or "How dominant is this person?". Answers were given on a 9-point scale, anchored with "very weak" and "very strong," or "not at all dominant" and "very dominant," respectively.

Each participant judged the faces on only one dimension (strength or dominance). The order of faces was randomized. Participants who judged dominance were instructed that by dominance, we meant "how much this person wants to influence other people and how much she or he is able to do so" (see Toscano, et al., 2014). For physical strength, no specific definition was given.

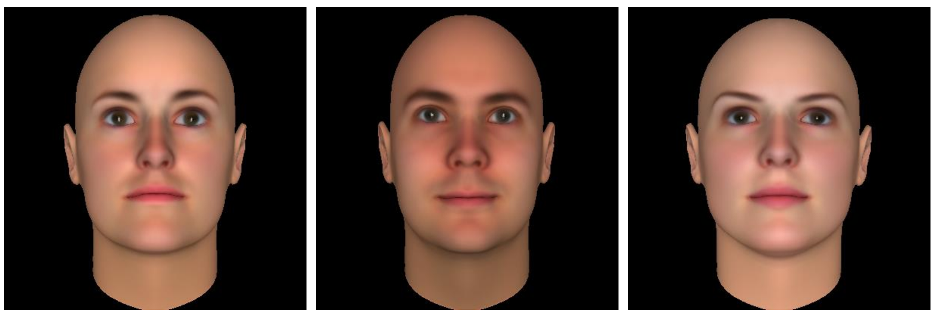


Figure 3.1*: Examples of the Stimuli used in Experiment 1*

Presenting all 300 faces to the participants of online experiments is likely to result in fatigue and low reliability. Therefore, we randomly divided the set of faces into four groups of 75 faces for each participant to answer. Each face was rated twice (150 ratings in total per participant). We had 87 participants judging dominance (23, 21, 23 and 20 participants for each group of faces respectively), and 107 participants judging physical strength (24, 26, 29 and 28 participants for each group of faces respectively).

3.6 Results and Discussion

To assess interrater reliabilities, we computed Cronbach's alpha for physical strength (M = 5.48, SD = 1.00) and dominance (M = 5.16, SD = 0.94). Reliability was high for physical strength (α = .98) and dominance (α = .96), when calculated using raw ratings, and when calculated using ratings averaged across each one the 300 faces (α = .97 for physical strength: α = .94 for dominance).

For each face, we aggregated the judgments of physical strength and dominance of all participants. Using the face as the unit of analysis, we computed Pearson correlations between the judgments of dominance and physical strength. Our analysis showed that the correlation was very high, $r = .84$, $p < .001$. Replicating previous findings (Toscano, et al., 2014), faces that are perceived as physically strong are also perceived as dominant, even when the two dimensions are judged by different observers.

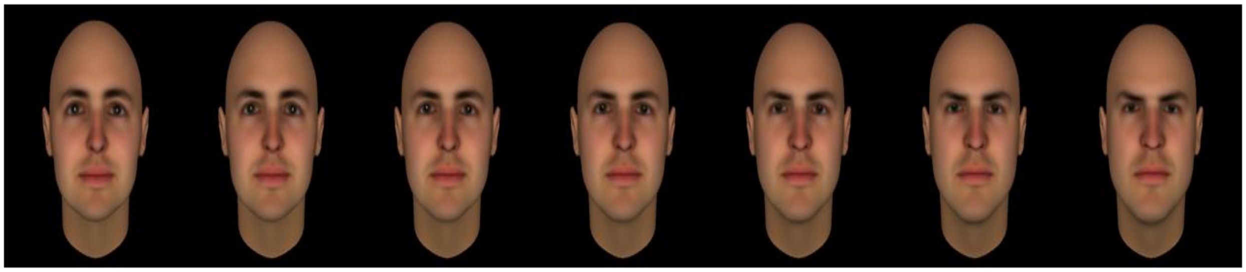
The judgments of social dominance and physical strength averaged across participants were then combined with the face space data underlying each of the rendered faces. We modelled the linear combination of dimensions in the face space that maximally correlated with the judgments. We only considered the shape dimension for doing so. FaceGen uses 50 dimensions to represent face shape and 50 dimensions to represent face reflectance (i.e. texture, color, brightness). We wanted to have men and women identities of the same race and, with this goal in mind, we only manipulated facial shape, not skin texture (reflectance). The manipulation of reflectance would have created, at some levels of the respective dimension, faces with a different skin color and gender

Additionally, combining judgments of dominance and strength, we created a model that is positively correlated with physical strength and negatively correlated with dominance - the Difference Dimension model. In this model, the faces go from very dominant and simultaneously weak (-3*SD*) to very strong but submissive (+3*SD*).

We then applied these three-dimensional models to 20 new identities, 10 men and 10 women (for details, Oosterhof & Todorov, 2011; Todorov et al., 2013). For each facial identity and all three dimensions, we created 7 renderings that show an identity from a negative extreme of the dimension (-3 *SD*) to the positive extreme (+3 *SD*), , and with 1 *SD* step in between (see **Figure 3.2**).

A)

Male

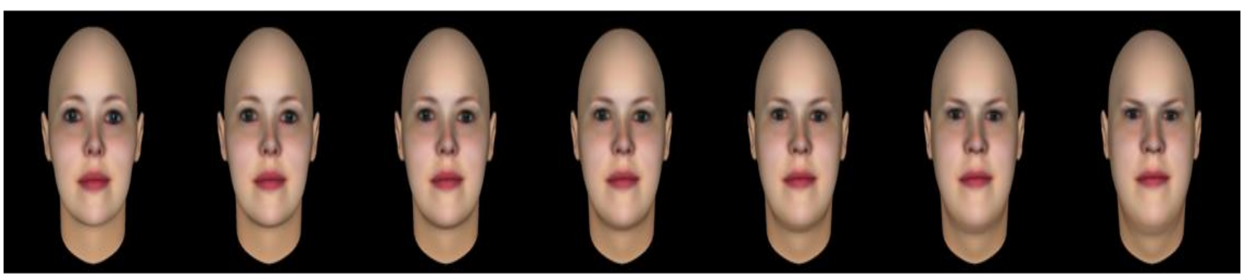


Female

B)

Male

Female



C)

Male

Female

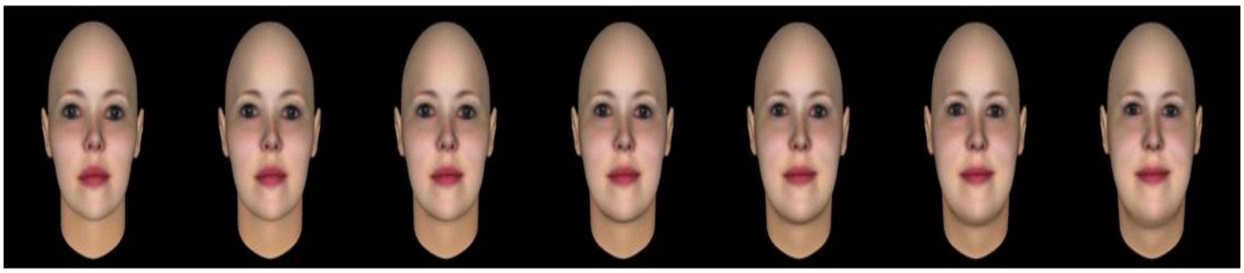


Figure 3.2*:* Models of trait judgments created in Experiment 1, example rendering using one male identity and one female identity, with model applied at from -3 SD (extreme left image) to +3 SD (extreme right image). (A) Model of Physical Strength Judgments; (B) Model of Dominance Judgments; (**C)** Difference Model, where -3 SD creates dominant(weak) and +3 SD creates strong(nondominant).

3.7 Study 2

In Study 1, we replicated that physically strong individuals are also judged as socially dominant, created computational models of dominance and strength in a face space, and generated renderings resulting from these dimensions as well as their difference. We discussed that the resulting faces look very much alike and that this appears to be true for both men and women, but, of course, an empirical test of this interpretation of the faces is missing. To provide such a test of the outcome of Study 1 is the first goal of Study 2.

More specifically, we will test the outcomes of our computational models. First, we want to validate that the models of physical strength and dominance are hard to tell apart. To empirically test the images created in Study 1, we first show to participants a face maximising strength and a face maximising dominance, and ask participants to select the one face they considered as physically stronger, or, in another condition, socially more dominant. We expect that participants will perform at chance level.

We then repeat this procedure with the faces generated from the difference dimension, with the goal to test whether physical strength and dominance can be discriminated here. Furthermore, we will investigate whether the pattern is the same for male and female faces.

3.8 Method

3.8.1 Participants. We recruited in total 676 participants (346 men), $M_{age} = 34.74$ years, $SD = 11.45$, from the United States of America and Western Europe via Amazon MTurk (paid: $1.5 USD) - see in **Table 3.1** details of the number of participants by study.

Table 3.1: Number of Participants by Study

			Judgment	
			Dominance	Strength
Study 2a	Target Gender	Male	$N_{male} = 28$, $N_{female} = 41$	$N_{male} = 32$, $N_{female} = 49$
		Female	$N_{male} = 52$, $N_{female} = 29$	$N_{male} = 58$, $N_{female} = 24$
Study 2b	Target Gender	Male	$N_{male} = 47$, $N_{female} = 53$	$N_{male} = 40$, $N_{female} = 64$
		Female	$N_{male} = 44$, $N_{female} = 34$	$N_{male} = 45$, $N_{female} = 36$

3.8.2 Materials. The stimuli consisted of the 20 identities created in Experiment 1. We used 20 extremely strong faces, 20 extremely dominant faces, 20 extremely strong(nondominant) faces and 20 extremely dominant(weak) faces (always +3 SD see Figure 3). Thus, we used the exemplars from Experiment 1 that were maximizing each specific dimension (i.e. physical strength, dominance and the subtraction of dominance from physical strength).

3.8.3 Procedure. Data were collected online, using Qualtrics (www.qualtrics.com). Participants were asked to choose from ten pairs of faces the person that they considered as physically stronger or, in another condition, more dominant. We also used ten filler pairs where one of the targets was much more dominant than the other (taken from the Dominance Model Database from Oosterhof & Todorov, 2008). Participants were told there were no right or wrong responses and to respond intuitively.

Each participant only judged on one of the dimensions (strength or dominance), selecting which person appeared to be physically stronger or more dominant, respectively. Each pair appeared twice and the position (left or right) of the faces was counterbalanced. The pairs of faces were presented at the center of the screen with a question below. The questions were "Which person do you consider as physically stronger?" or "Which person do you consider as more dominant?". As in Experiment 1, we defined dominance as "how much this person wants to influence other people and how much she or he is able to do so". In Study 2a, each pair consisted of one face that was extremely strong (+3 *SD* physical strength) and one that was extremely dominant (+3 *SD* dominant). In Study 2b, each pair consisted of one face that maximized what differentiated dominance from strength (i.e. +3 *SD* dominant weak faces), and another face maximized what differentiated strength from dominance (i.e. +3 *SD* strong nondominant faces). The design of both studies 2a and 2b was: 2 (Picture: high strength vs. high dominance, within) x 2 (judgment: stronger one vs. more dominant, between) x 2 (position: left vs. right, within) x 2 (Target Gender: Men vs Women, between).

3.9 Results

Answers were coded as 1 if the nominally correct picture was chosen (e.g., if the very strong instead of the very dominant face was chosen when the task was to select the stronger face), and 0 otherwise. Separate scores were created for the two tasks (identify physically stronger vs. more dominant), and male or female target faces. We tested the averaged scores against .5 (ie., chance). For these comparisons, we also computed effect size $r = (t^2/(t^2+\text{df}))^{½}$. In addition, we also explored whether gender of participant had an influence, by submitting the scores to independent samples *t*-tests. We report below the outcomes of these *t*-tests.

*3.9.1 Study 2a***.** Study 2a showed two faces that were both maximising one dimension (strength or dominance). When choosing the stronger face from a pair of male faces, participants chose the very strong face instead of the very dominant face in 52.4% of the cases. One-sample *t*-tests against chance (0.5) showed that this choice was not significantly different from chance, t (80) = 1.51, p = .134, r = .17.

When choosing the more dominant face from a pair of male faces, choices were not better than chance (p = .362), but there were significant differences between participants' gender. Female participants choose the dominant face more often (53.1%) than male participants did (48.2%), t (67) = 2.05, p =.044. Men chose (wrongly) the strong face slightly more often (51.8%) instead of the dominant one (48.2%), but performed still at chance, t (27) = -1.03, p = .31, r = .19. Women chose (correctly) the dominant face slightly more often (53.1%), but this differed from chance only marginally, t (40) = 1.97, p = .06, r = .30.

When choosing the stronger face from a pair of female faces, participants selected the strong faces (+3 *SD* physical strength) rather than the dominant face (+3 *SD* dominance) in 52.7% of the times. This selection was not better than chance, t(81) = 1.41, p = .163 ., r = .15.

When choosing the more dominant face from a pair of female faces, the highly dominant face was chosen in 55% of the cases. This was significantly different from chance, t (80) = 2.56, p = .012 ., r = .28.

3.9.2 Study 2b. Study 2b showed two faces that maximised one dimension over the other. When choosing the stronger face from a pair of male faces, the participants selected the strong (nondominant) instead of the dominant (weak) face in 82.5 % of the cases. This preference was significantly different from chance, t(103) = 14.87, p <.001, r = .83.

When choosing the more dominant from a pair of male faces, participants actually wrongly selected the strong (nondominant) in 56.6% cases instead of the dominant(weak) face (43.4%), which differed from chance t(99) = -2.21, p = . 029, r = .42. However, we found gender differences, t(98) = -2.15, p =.034, r =.21. The unexpected difference was due to the male participants: they chose the strong(nondominant) face more often (63.4%) than the dominant(weak) face (36.6%), which different from chance, $t(46) = -3.12$, $p = .003$, $r = .42$.[6] Women on the other hand selected the strong (nondominant) face slightly more often (50.7%), but were at chance, $t(52) = -0.16$, $p = .872$, $r = .02$.

When choosing the stronger face from a pair of female faces, the strong(nondominant) face was selected more often (74.6%). This preference was significantly different from chance, $t(80) = 7.62$, $p <.001$, $r = .65$.

Finally, when choosing the more dominant face from a pair of female faces, participants selected the dominant(weak) faces more often (58.7%) than the strong (nondominant) face (41.3%). This preference was significantly different from chance, $t(77) = 3.03$, $p = .003$, $r =.33$.

In sum: When having to pick the more dominant or the stronger face from two faces where one was generated from the dominance dimension and the other was generated from the strength dimension, participants could not distinguish between the models; they basically performed simply at chance. However, when doing the same task with pictures generated from the difference dimension, we observe a double asymmetry: When looking for the stronger face, participants actually choose significantly more often the face that maximized strength while minimizing dominance, and this was true for male and female faces. When looking for the more dominant among two *female* faces of which one maximised strength over dominance and the other maximised dominance over strength, they chose (correctly) more often the face that maximised dominance. However, when they looked for the more dominant among two *male* faces, they actually mistakenly chose more often the face maximising strength over dominance, committing this error above chance levels. At first, this appeared to happen especially for male participants, but the replication reported in footnote 6 suggests this happens for both genders.[7]

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[6] Because of the unexpected direction of the effect, we conducted another experiment in order to replicate the results of Study 2b for the task of selecting the more dominant face from a pair of male faces generated from the difference dimension. We recruited 90 (47 female) participants from Mturk. The mean age was 35 years (*SD*= 10.17). Again, we found that the strong (nondominant) face was chosen more often (66.3%) than the dominant (weak) face (33.7%), $t(89) = - 5.33$, $p < .001$, $r = .49$. However, we did not find gender differences as in the previous study, $p = .39$.

[7] Because our models may be somewhat male-biased (see General Discussion), we ran an additional study to check whether female faces were correctly identified as females. We asked the participants (N = 98) recruited on MTurk to select the gender for each one of the faces used in Study 2. As we expected, male faces from Dominance and Physical Strength models were identified in most cases as males (99%), $p < .001$. However, female faces were considered as males in most cases (67%), $p < .001$. Regarding faces generated from the difference model, male faces were still identified as males in almost every case (99%), $p < .001$. Female faces from this model were correctly identified as

3.10 General Discussion

In the current chapter, we created models of physical strength and dominance judgments to explore whether these two judgments differ. These models were built on the notion of statistical face space (Valentine, 1991). The models resulted from judgments of 300 computer-generated faces (Oosterhof & Todorov, 2008) along the two dimensions, where each dimension represents the maximum amount of explained variance from the respective judgment. Importantly, these models are data-driven and are not biased by the manipulation of single features. More specifically, these models enable us to investigate all the information people use when evaluating physical strength and dominance. Consequently, we can visualise the representations of physical strength and dominance.

We found several indications that the judgments of physical strength and dominance are highly aligned. First, replicating earlier findings, faces that were rated as very dominant are also rated as physically strong, even though these ratings came from different participants. Secondly, as a result, we show for the first time that the model that maximises physical strength and the model that maximises dominance based on the participants' ratings lead to faces that look very much alike. Study 2a empirically confirmed that participants were at chance at discriminating faces generated from these two models. Thus, increases in dominance and physical strength are expressed similarly in changes in facial shape.

The facial properties that change with increases in both dimensions are lengths of eyes and chin, eyebrows height, and width of nose and face, confirming earlier results (Toscano et al., 2014). In addition, as faces become more dominant or strong, they seem to show more masculinity and anger (see also Sell, Tooby, et al., 2009).

Some gender differences seem to emerge from the visualisations: In men, the increase in dominance and physical strength seems to be linked primarily with muscularity. Dominance and physically strength in women, however, appear to be more associated with bodily weight. However, the initial 300 faces judged by the participants in Study 1 are more male than female

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females in the majority of cases (89%), $p < .001$. Thus, the fact that we did not find strong effects of target gender in Study 2a could thus be due to miscategorization of the face gender. However, the face gender effects in Study 2b arise from correct gender categorizations.

and the resulting model is male-biased. Additionally, the models with female faces might have some limitations. Because the female heads are bald, this might bias the judgments of the participants because hairless faces tend to be judged as males (Dotsch & Todorov, 2012). As reported in Footnote 7, female faces that resulted from Dominance and Physical strength models can be misidentified as males. However, female faces from the Difference model were identified in most cases as females.

Even though physically strong and dominant faces look very much alike, our face models make it possible to compute what differentiates strength from dominance, and to create faces that maximise this difference in one or the other direction. Thus, we can see how a face goes from extremely dominant(weak) to extremely strong(nondominant). This permits us to visualize the perceptual cues that discriminate perceptions of physical strength from perceptions of dominance.

Inspection of the renderings from this difference model shows that the strong (nondominant) faces have a rounder shape characterized by more facial fat and a less threatening look than the strong faces from the models of physical strength judgments. Moreover, dominant(weak) faces have less muscularity and also a less angry look than the dominant faces from the models of dominance judgments. Both strong(nondominant) and dominant-(weak) faces seem to show less angry expressions than the faces from the respective models.

Additionally, it is possible to see from the dominant(weak) to the strong (nondominant) extreme that the faces increase in facial fat. It seems that strong (nondominant) persons are thought to have more body fat which suggest an above average weight (Donofrio, 2000). Previous studies also show that physical strength and body fat shared some resemblances (Windhager, et al., 2012). Other changes also occur as eyes become smaller, the eyebrows lower and the noses flatter.

When we presented the faces that maximised one difference over the other to participants in Study 2b, we found two interesting asymmetries. First, when participants had to choose the stronger face, they correctly selected the face maximising physical strength over dominance more often than chance, and they did this for both male and female faces. Thus, participants were able to correctly differentiate strong (nondominant) faces from dominant (weak) faces when deciding about physical strength. However, when participants had to choose the more dominant face, the picture got complicated, even though only the judgment changed while the pictures stayed the same. First, when participants did this task for female faces, they had some success doing so and selected the dominant (weak) face more often than the strong (nondominant) face. That was not the case for male faces. When selecting the more dominant male face, participants tended to choose, in fact, the strong (nondominant) face more often than the dominant (weak) face. It is possible that this bias in the wrong direction is stronger for male participants (but see Footnote 6).

In sum, pure strength can be distinguished from pure dominance in both male and female faces, but pure dominance can only be distinguished from pure strength in female faces, while, in fact, pure strength tends to be mistaken for pure dominance in male faces. These asymmetries suggest that the degree to which dominance is equated with strength differs between male and female faces. Note that this result only became obvious when using the difference models, because under normal circumstances dominance and strength are too conflated.

We have to recognize that the absence of a social context might have played a role. It is possible that participants would be more prone to identify dominance with the dominant-(weak) faces than with strong(nondominant) faces in a context essential for certain skills as emotional intelligence or technical expertise. However, this double asymmetry cannot be purely explained with different morphologies of male and female faces because the two tasks (selecting the most dominant vs. selecting the stronger one) used exactly the same pictures. It is more likely to have its root in the conflation of the concepts of strength and dominance especially for male targets. According to some authors, men are more encouraged by our culture to apply their intentions through physical force and use more physical aggression than women (Bettencourt and Miller, 1996; Eagly and Steffen, 1986). Furthermore, the use of bodily strength seems to play a more instrumental role in men. Men use their physical strength to gain influence whereas in women the use of physical strength tends to be seen as a loss of power (Alexander, Allen, Brooks, Cole, & Campbell, 2004; Campbell & Muncer, 1994; Campbell, Muncer, & Coyle, 1992; Schubert, 2004). Therefore, it is likely that the association between physical strength and social dominance will be more present in men. In women, physical strength will be seen as being associated with powerlessness. This might explain why we tend to associate more physical strength with dominance for male targets when the participants have to judge the difference model.

Another possibility is that the difficulties in dissociating dominance from physical strength in men are linked to evolutionary mechanisms of fighting competition within males in order to exclude same-sex competitors (Darwin, 1871). Thus, physical characteristics that could increase the fighting ability (i.e. physical strength) would increase the mating opportunities for males and, consequently, their social influence. The mechanisms of sexual selection favoured strong and larger bodies in males, but not in females. For instance, men have on average 61% more total muscle mass than women, especially in upper body muscles (Lassek & Gaulin, 2009). Therefore, females could not monopolize men or mate them through the use of sheer physical force. Moreover, typical female traits such as larger breasts and hips are not associated with physical strength, but with physical attractiveness (see Puts, 2010). As a result, their social dominance seems to be less associated with physical strength. For instance, Sell, Tooby, et al. (2009) found that women's physical strength does not increase their feelings of entitlement, but attractiveness does.

Another related reason might be the role of weight cues for attractiveness judgments. As Coetzee, Cehn, Perrett and Stephen (2010) have demonstrated, weight can be accurately judged from the human face. Moreover, overweight women are seen as less attractive than women with normal or lower weight (see also Hume & Montgomerie, 2001). We can visualize that the dominant (weak) faces have less facial fat than the strong (nondominant) faces. This might increase the unattractiveness of the latter and, consequently, diminishes their social dominance. In addition, more facial fat is also correlated with more health problems (Tinlin et al., 2013). Therefore, more facial fat might increase the perception of less fitness.

Taken together, our data suggest that the ability to apply bodily actions, that is, physical strength, is strongly related to social dominance primarily for men.

3.11 Conclusion

In this chapter, we asked whether mental representations of faces of socially dominant individuals differ from representations of faces of physically strong individuals. Our data show that physical strength and dominance facial representations, when visualised from a computational model of both judgments, are highly similar. Additionally, participants in an empirical study were not able to distinguish faces when are presented with exemplars of both dimensions. However, it is possible to combine the model of strength with the model of dominance, and to generate faces that maximize one over the other. When the participants were presented with such faces they could identify the faces maximized for strength when searching for strength, and also female faces maximized for dominance when searching for dominance, but they had trouble recognizing male faces maximizing dominance when looking for dominance, and chose faces maximised for strength instead. In sum, we find that physical strength and social dominance judgments are strongly correlated and our representations of both look alike, but we tend to mistake strength for dominance more than we mistake dominance for strength, especially in male faces.

CHAPTER IV[8]

HEAD POSITION AND GAZE DIRECTION INFLUENCE ON JUDGMENTS OF DOMINANCE AND PHYSICAL STRENGTH

Humans, as social animals, study each other's faces to learn about the emotional and mental state of others, but also to infer other's stable traits. *How* facial features influence the formation of impressions has become an increasingly studied topic in recent years (Oosterhof & Todorov, 2008; Todorov, Said, & Verosky, 2011; Zebrowitz, 1997, 2011). Multiple trait impressions from faces can be made rapidly and involuntarily (Bar, Neta, & Linz, 2006; Willis & Todorov, 2006). Imaging studies suggest that we automatically infers traits from faces in a specialized system (Engell, Haxby, & Todorov, 2007; Todorov & Engell, 2008). In addition to studying the process of face perception and trait inference, recent research has also investigated *what* traits are preferentially inferred from faces. One of the most important traits gleaned from faces seems to be dominance (Oosterhof & Todorov, 2008; Sutherland et al. 2013).

An individual is typically judged as dominant if the face suggests maturity, masculinity, and physical strength (Sell, Cosmides, et al., 2009; Toscano, Schubert, & Sell, 2014; Windhager, Schaefer, & Fink, 2011). Visual representations of facial dominance and physical strength show many similarities (Toscano, Schubert, Dotsch, Falvello, & Todorov, 2014). Notably, however, almost all studies investigating these facial judgments were done with stimuli that used a direct gaze and the same head position, in the interest of experimental simplicity. Generally, studies of face perception involve judgments of stimuli in full-frontal views (see Zebrowitz, 1997).

However, facial information extracted from dynamic changes may have more ecological validity (McArthur and Baron, 1983; Zebrowitz, 2011). In real-life situations, faces are viewed in multiple positions (Jenkins et al., 2011; Rule, Ambady, & Adams, 2009; Todorov & Porter, 2014). Here, we intend to make an exploratory analysis of how dominance and physical strength

[8] This chapter is based on the paper Toscano, H., & Schubert, T. W. (2014). *The role of head position and gaze direction on physical strength and dominance judgments*. Manuscript submitted to publication.

judgments from faces may change according to contextual influences such as gaze direction and head position.

4.1 Facial Dominance and Physical Strength

Dominance is one of the main traits inferred from faces. Oosterhof and Todorov (2008) found that along with trustworthiness, dominance is one of main dimensions underlying impressions from faces (see also Sutherland et al., 2013) Facial dominance has important social consequences, from career success in the Army (Mueller & Mazur, 1997) to courtroom decisions (Zebrowitz and McDonald, 1991) and elections (Chiao, Bowman, and Gill, 2008; Little, Burriss, Jones, and Roberts, 2007; Rule et al., 2010). For instance, cadets with more dominant faces had a higher probability of ascending in their careers (Muller & Mazur, 1997). Additional evidence from courtroom decisions demonstrated that higher penalties are associated with more mature-looking faces than with baby faced persons (Zebrowitz & McDonald, 1991). Moreover, political elections seem to be influenced by facial dominance (Chiao, Bowman, and Gill, 2008; Little, Burriss, Jones, and Roberts, 2007; Rule et al., 2010).

People show consensus on facial dominance judgments. Faces are judged as dominant when they have certain features: small eyes, low brow, a more angular form, and large chin (see Zebrowitz, 1997). In addition, facial dominance seems to be related to cues of physical strength (Oosterhof & Todorov, 2008; Sell, Cosmides, et al., 2009). Physically strong men are judged as more dominant (Windhager, et al., 2011). Masculine men are also judged as dominant and physically strong (Jones et al., 2010). Judgments of dominance and physical strength are highly correlated (Toscano, et al., 2014). Using computer-generated and natural faces, these authors showed that observer ratings of dominance and physical strength have facial properties that predict both judgments: low brow, small eyes, large chin, narrow mouth and wider nose.

In sum, dominance and physical strength are closely associated. Nonetheless, this relationship between dominance and physical strength judgments was studied with faces directly looking into the camera and thus at the perceivers and with the same neutral head position. Changes of faces across time and space may provide more valid information to the perceivers (McArthur and Baron, 1983; Zebrowitz, 2011). One of the main reasons is that faces are viewed in daily interactions in multiple positions and with different gazes (Jenkins et al., 2011; Rule, et al., 2009; Todorov & Porter, 2014). In the present work, our goal will be to explore how contextual and dynamic changes influence dominance and physical strength judgments. We had three main questions. How do dominance and strength judgments change depending on gaze and head positions? Will the relationship between dominance and physical strength hold for faces with different gaze directions and head positions? Do dominance and physical strength change equally depending on gaze and head position?

4.2 Overview of the Studies

In the studies reported here, we will test the influence of head position and gaze direction on dominance and physical strength judgments. Previous studies have shown that direct gaze is seen as a threat by many animals, including humans (Argyle, & Cook, 1976; Perrett & Mistlin, 1990). Additionally, in adults, gaze direction is also related to physical contests and grooming (Chance, 1967; Van Hoof, 1962). Dominance displays are typically expressed with direct gaze. Conversely, submissive displays often involve averted gaze (e.g. Redican, 1982). Direct gaze also increases judgments of dominance (Main et al., 2009).

One physical constraint and correlate of gaze is head position. Head position might also influence dominance judgments, but there is surprisingly little evidence about this. Some studies suggest that a raised head increases judgments of dominance (e.g. Mignault & Chaudhuri, 2003). This work has for instance shown that a person with the head in a higher position is perceived as more dominant compared in a lower position. However, in this study gaze was not manipulated – in fact, the stimuli faces had closed eyes. In another study, participants were asked to select a portrait to represent either an influential leader or an assistant from a set of three pictures that were either shot from the front, from above, or from below. The picture taken from below was more often chosen for the leader, and the picture from above was more often chosen for the assistant (Giessner, Ryan, Schubert, & van Quaquebeke, 2011). However, the portrayed individuals always looked into the camera.

These findings notwithstanding, we believe that when people feel threatened or want to threat somebody else, they actually do not always raise their heads to become more dominant. For instance, in boxing matches, the fighters tend to lower their heads in order to defend and attack their opponents. In many physical fights it would not make sense for someone to raise his/her head because it would increase the risks of being hit: a raised head is more exposed to blows. Moreover, even in social discussions we sometimes lower our heads and look directly into others' eyes in order to try to convince others of our arguments. The relation between head position and dominance thus seems to be more complicated.

Therefore, the question of how gaze and head position affect assessments of dominance and physical strength from faces seems largely unresolved. We aim to explore whether physical strength and dominance judgments from faces change in a similar way according to head position and gaze.

4.3 Study 1

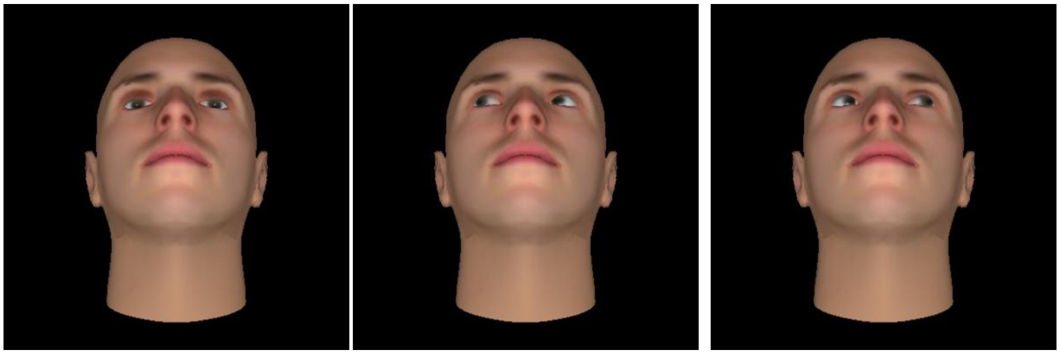
4.4 Method

4.4.1 Participants. We recruited 93 participants (68 female, M_{age} = 23.26, *SD* = 5.95) from the participants' pool of ISCTE-IUL. The participants were told that they would enter in a lottery and could win an 80 € in vouchers for participating in the study.

4.4.2 Materials. In all studies, we used computer-generated faces. For every face created we used three different angle positions and two types of gaze (direct vs. averted). We created 60 identities in FaceGen software (FaceGen Modeller program version 3.5, http://facegen.com), 30 female and 30 male using the gender manipulation in FaceGen. All stimuli were White faces. Additionally, for each picture we generated three head positions in FaceGen: seen from above or -25º, from the front or 0º, and seen from below or +25º degrees, and three gaze directions: direct, averted to the right, and averted to the left. We manipulated the position in the pitch angle of the camera tab in FaceGen. The gaze direction was transformed in the morph tab of FaceGen. In total, we created 540 faces (60 identities x 3 positions x 3 gazes). All faces were 400 x 400 pixels – see **Figure 4.1**.

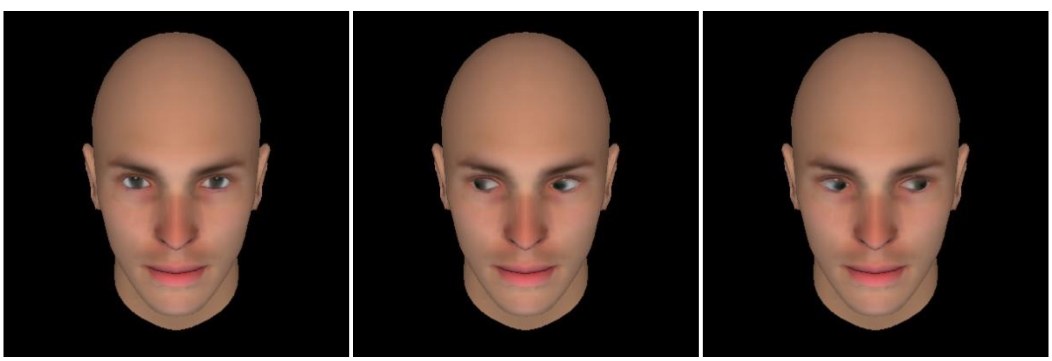
a) Male

From Below



From the Front

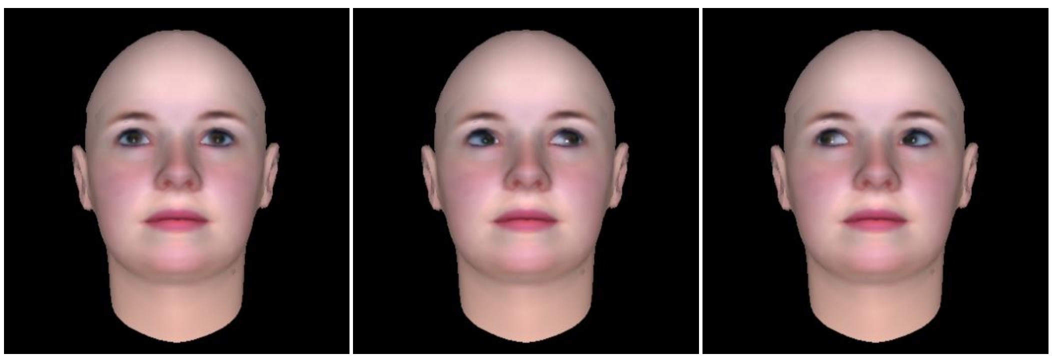
From Above



b) Female

From Below

From the Front



From Above

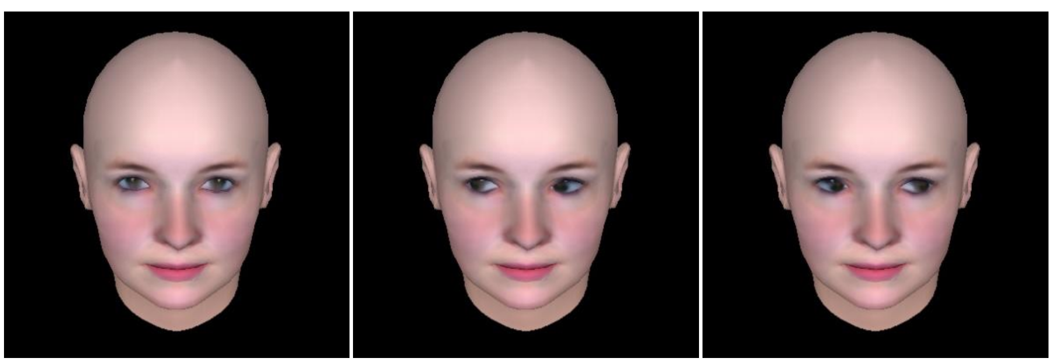


Figure 4.1: Examples of pictures used in all studies: a) male face and b) female face across all head positions (from below, from the front and from above) and gaze direction (direct and averted -rightward and leftward).

4.4.3 Design and Procedure. Data for study 1 were collected online using Qualtrics (www.qualtrics.com). Participants were asked to respond intuitively. They were told that there were no right or wrong answers. All participants judged 60 pictures on physical strength or dominance, and each picture was judged twice on each dimension to increase reliability. Order of pictures was randomized. Each picture was shown at the center of the screen with a question below: "How physically strong is this person?" or "How dominant is this person?" for the two dependent variables with response scales from 1 (very weak or not at all dominant) to 7 (very strong or very dominant). Before the dominance block, we explained that by dominance we meant "how much this person wants to influence other people and how much she or he is able to do so ".[9] A definition of physical strength was not considered necessary.

Because judging all 60 faces twice (120 trials) with every head position and gaze direction (120 x 3 x 2 = 720 trials in total) would have resulted in a very difficult task, we created 12 blocks (6 for each trait judgment: dominance vs physical strength) of 60 faces (30 male and 30 female) each for each participant to answer. Each face was rated twice (120 ratings in total per participant).[10] Within each block all 60 faces were of different identities. Moreover, each identity appeared in each block with a different head position and/or gaze. Thus, each block was constituted by the same identities but in different head positions and/or gaze directions. After the judgment task, we computed the means of each participant for each trait dimension, physical strength and dominance. We did not distinguish between gaze averted to the left or right. In sum, the study had a 3 (Head Position: from above (+25º) vs. front (0º) vs. below (-25º), within) x 2 (gaze: direct vs. averted, within) x 2 (Gender of the target: male vs. female, within) x 2 (judgment: physically strength vs. dominant, between) design.

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[9] In this definition we associate motivation and potential to influence in order to define dominance. Influence is one of the main qualities of social dominance (e.g., Cheng, Tracy, Foulsham, Kingstone, and Henrich 2013).

[10] There was a slight problem with our experiment in Qualtrics across all five studies. More specifically, there were 2 blocks across the 12 used, where the participants judged twice 59 faces (118 judgments in total) and not 60 (120 judgments in total) as in the other blocks.

4.5 Results

We conducted for each judgment (physical strength vs. dominance) a three-way ANOVA with the within-subjects variables gender of the target (male vs. female), head position angle (+25º vs. 0º vs. -25º) and gaze direction (direct vs. averted).

4.5.1 Dominance judgments (N = 48). For dominance judgments, there was a significant effect of head position, $F(2, 94) = 11.77$, $p < .001$, $n_p^2 = .20$. In addition, we found a main effect of gaze direction, $F(1, 47) = 47.72$, $p < .001$, $n_p^2 = .504$. Additionally, we found a main effect of gender, F (1, 47) = 69.38, $p < .001$, $n_p^2 = .596$) – see footnote for the mean patterns of the main effects[11]; all the means and standard deviation of the main effects across all studies will be in footnotes.

We also found an interaction of head position and gaze, $F(2, 94) = 15.04$, $p < .001$, $n_p^2 = .242$). There were no significant differences in dominance judgments across the three positions when the gaze was averted, $p_s > .05$. However, when gaze was direct, participants judged the faces seen from below as more dominant ($M = 4.51$, $SD = 0.93$) than faces seen from the front ($M = 3.75$, $SD = 0.78$, $p < .001$) and from above ($M = 4.14$, $SD = 0.84$, $p = .002$). Direct gaze faces seen from above were still judged significantly more dominant than faces seen from the front, $p < .001$.

We also observed an interaction of head position and gender, F (2, 94) = 12.54, $p < .001$, $n_p^2 = .211$. Male faces were judged as more dominant when seen from below ($M = 4.42$, $SD = 0.94$) or above ($M = 4.45$, $SD = 0.97$) than when seen from the front ($M = 4.04$, $SD = 0.79$), *all* $p_s < .001$. The difference between faces when seen from above and from below was not significant, $p = .827$. Male faces were also judged as significantly more dominant when seen from above when compared to faces seen from the front, $p < .001$ Male faces seen from below and from above were

[11] In relation to head position, faces seen from below (+25º) were judged as more dominant ($M = 4.03$, $SD = 0.79$) than faces seen from the front (0º, $M = 3.60$, $SD = 0.71$), $p < .001$. Faces seen from above (-25º) were *also* judged as more dominant ($M = 3.84$, $SD = 0.76$) than faces seen from the front, $p = .004$. The difference in dominance between faces seen from below and from above was only marginal, $p = .083$. Additionally, faces with direct gaze were judged as more dominant ($M = 4.13$, $SD = 0.75$) than faces with averted gaze ($M = 3.51$, $SD = 0.72$), $p < .001$. For gender effects, male faces ($M = 4.31$, $SD = 0.80$) were considered more dominant than female faces ($M = 3.33$, $SD = 0.76$), $p = .001$.

not judged differently, p =.807. Female faces were judged as more dominant when they were seen from below (M = 3.63, SD = 0.82) rather than from the front (M = 3.14, SD = 0.87) or from above (M = 3.22, SD = 0.85). The differences in female faces seen from below in relation to faces seen from the front and from above positions were significant, $p_s < .001$. However, there were no significant difference between faces seen from the front and seen from above positions, p = .373.

There were no significant interactions between gaze and gender, $F(1, 47) = 0.559$, p = .459, n_p^2 = .012) or between head position, gaze and gender, $F(2, 94) = 0.225$, p = .459, n_p^2 = .005.

4.5.2 Physical Strength Judgments (*N = 45*). We found a main effect of head position, $F(2, 88) = 28.52$, $p < .001$, n_p^2 = .393, gaze, $F(1, 44) = 21.96$, $p < .001$, n_p^2 = .333, and gender, $F(1, 44) = 162.23$, $p < .001$, n_p^2 = .787 – see footnote[12].

There was an interaction of head position and gaze, $F(2, 88) = 3.42$, p = .037, n_p^2 = .072. When the gaze was direct, faces seen from below were judged as physically stronger (M = 4.53, SD = 0.55) than faces seen from the front (M = 4.03, SD = 0.53, p = .001) and from above (M = 4.26, SD = 0.53), $p_s < .001$. Faces seen from above were also judged as stronger than faces seen from the front, $p < .001$. Regarding averted gaze faces, faces seen from below were again judged as stronger (M = 4.23, SD = 0.61) than faces seen from the front (M = 3.94, SD = 0.63, $p < .001$) and from above (M = 4.00, SD = 0.57, p = .003). There were not significant differences between faces seen from the front and from above, p = .374.

Head position and gender also interacted, $F(2, 88) = 16.11$, $p < .001$, n_p^2 = .268. As in dominance judgments, physical strength judgments of male faces increased when the head was seen from below (M = 5.21, SD = 0.66) or from above (M = 5.23, SD = 0.68) compared to when it was seen from the front (M = 4.92, SD = 0.70). Faces seen from below and from the front differed significantly, $p < .001$. Male faces seen from above were also judged as significantly stronger than

[12] Faces seen from below were judged as stronger (M = 4.38, SD = 0.54) than faces in a frontal position (M = 3.99, SD = 0.55), $p < .001$. Moreover, they were also considered as stronger than faces seen from above (M = 4.14, SD = 0.49), $p < .001$. Faces seen from above were also seen as physically stronger than faces in a frontal position, p = .009. Faces with direct gaze were also judged as physically stronger (M = 4.27, SD = 0.48) than faces with averted gaze (M = 4.06, SD = 0.54). Male faces (M = 5.12, SD = 0.62) were judged as stronger than female faces (M = 3.21, SD = 0.76).

male faces seen from the front, p < .001. Male faces seen from below and from above did not show any significant differences, p =.829. Male faces were regarded as stronger if they were seen from below (M = 3.54, SD = 0.77) rather than from the front (M = 3.06, SD = 0.85) or from above (M = 3.04, SD = 0.83). Differences between female faces seen from below in relation to ones seen from the front and from above were significant, p_s < .001. Female faces seen from the front and from above did not show meaningful differences, p = .774.

We did not find interactions between gaze and gender, $F(1, 44) = 0.574$, $p = .453$, $n_p^2 = .013$. There was also no three-way interaction between position, gaze and gender, $F(2, 88) = 0.834$, $p = .438$, $n_p^2 = .019$.

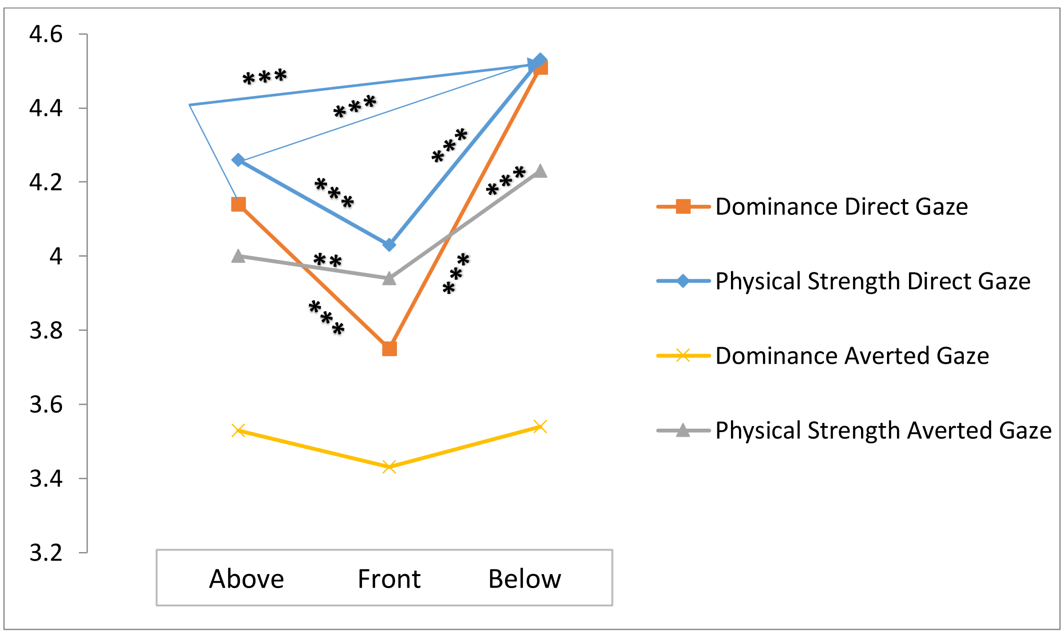

Figure 4.2: Judgments of Dominance and Physical Strength by gaze and head position - Study 1. * p < .05, ** p < .01, *** p < .001.

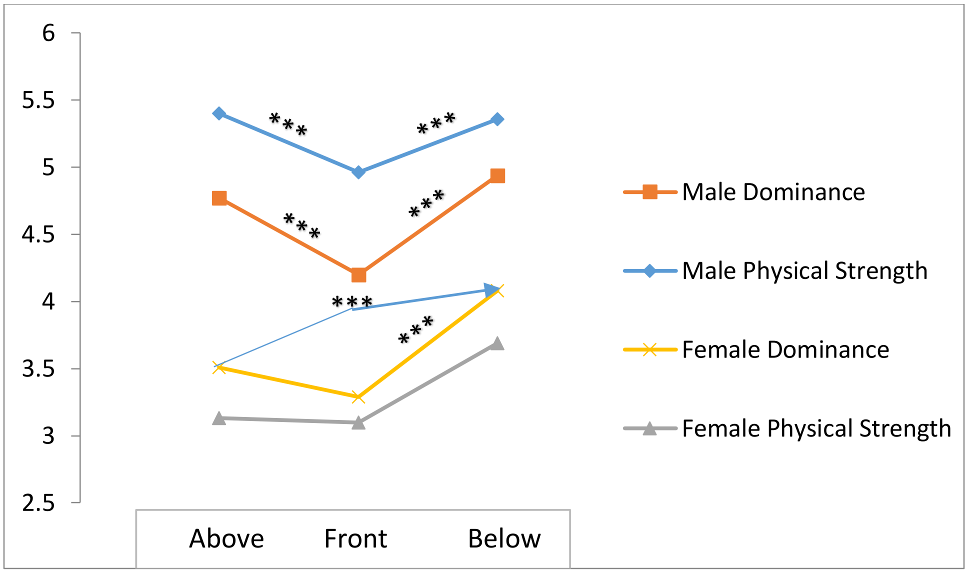

Figure 4.3: Judgments of Dominance and Physical Strength with direct gaze by gender and head position - Study 1. * $p < .05$, ** $p < .01$, *** $p < .001$;

4.6 Discussion

Head position and gaze direction seemed to impact dominance and physical strength judgments similarly. Faces are judged as more dominant and stronger when they gaze directly into the camera, and when they were seen from below *or* from above rather than from the front. As expected, male faces were judged to be more dominant and stronger than female faces.

Besides these similarities between both judgments, gaze direction and head position seem to play a larger role in dominance than in physical strength judgments.

Figure **4.2** shows that the impact of gaze along the levels of head position was greater on dominance judgments than on strength judgments.

In sum, direct gaze leads to being judged as more dominant and also as stronger. However, the effect on strength is somewhat smaller. Furthermore, gaze and head position interact with each other. Faces with direct gaze are judged as more dominant and stronger when seen from above or below rather than from the front. However, when eyes are averted, head position has less of an effect on physical strength judgments, and no effect anymore on dominance judgments (which become low). Gender also interacted with head position. Both moving the head down and moving the head up similarly increase judged dominance and strength for male faces. However, for female faces the highest ratings of strength and dominance are usually when seen from below (above and frontal positions were lower and not significantly different). Overall, both judgments show a very similar pattern across head position and gaze direction. Given the exploratory nature of these findings, we intend to replicate these results in the next study.

4.7 Study 2

4.8 Method

4.8.1 Participants. We recruited 137 participants (74 female, M_{age}=36.46) through Amazon Mechanical Turk (Buhrmester, Kwang, and Gosling, 2011). We paid $1.75 USD to each participant.

4.8.2 Materials. They were the same as in Study 1.

4.8.3 Design and Procedure. Design and procedure replicated Study 1.

4.9 Results

As in the previous study, we conducted a three-way ANOVA with the within-subjects variables head position (from below vs. from the front vs. from above) gaze direction (direct vs. averted), gender of the target (male vs. female), within) for each judgment (physically strength vs. dominant).

4.9.1 Dominance Judgments (*N=66*). There was a main effect of head position, $F(2, 130) = 13.12$, $p < .001$, $n_p^2 = .168$). There was also a main effect of gaze direction, F (1, 65) = 95.88, *p*

$< .001$, $\eta_p^2 = .596$. Moreover, we also found differences in dominance judgments according to targets' gender, $F(1, 65) = 187.78$, $p < .001$, $\eta_p^2 = .743$ – see footnote[13].

On judgments of dominance, we found an interaction between head position and gaze direction, $F(2, 130) = 25.92$, $p < .001$, $\eta_p^2 = .285$. Regarding faces with direct gaze, faces seen from below ($M = 4.86$, $SD = 0.91$) and from above ($M = 4.64$, $SD = 0.82$) were judged as significantly more dominant than faces seen from the front ($M = 3.92$, $SD = 0.79$), $p_s < .001$. We did not find significant differences between faces seen from below and from above, $p = .117$. When the gaze was averted, there were not significant differences between faces seen from below ($M = 3.33$, $SD = 1.02$), from the front ($M = 3.33$, $SD = 0.97$) and from above ($M = 3.47$, $SD = 0.98$), *all* $p_s > .05$.

Head position interacted with gender, $F(2, 130) = 48.64$, $p < .001$, $\eta_p^2 = .428$. Male faces seen from above ($M = 4.89$, $SD = 0.91$) were seen as significantly more dominant than faces seen from below ($M = 4.51$, $SD = 0.80$, p= .002) and from the front ($M = 4.16$, $SD = 0.84$, p <.001) positions. The differences between faces seen from below and the front were also significantly different, $p < .001$. Female faces seen from below ($M = 3.68$, $SD = 0.92$) were judged as significantly more dominant than faces seen from the front ($M = 3.09$, $SD = 0.84$) and from above ($M = 3.22$, $SD = 0.76$), $p < .001$. Faces seen from the front and from above did not show significant differences, $p = .232$.

In this study we also observed an interaction between gaze direction and gender, $F(1, 65) = 5.10$, $p = .027$, $\eta_p^2 = .074$. Male faces with direct gaze ($M = 5.11$, $SD = 0.62$) were judged as more dominant than when gaze was averted ($M = 3.94$, $SD = 1.03$), $p < .001$. The same pattern occurs in female faces with direct ($M = 3.83$, $SD = 0.74$) and averted gaze ($M = 2.83$, $SD = 0.82$), $p < .001$.

The three-way interaction between head position angle, gaze direction and gender was not significant, $F(2, 130) = 0.049$, $p = .948$, $\eta_p^2 = .001$.

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[13] Faces seen from below ($M = 4.10$, SD = 0.76) and from above ($M = 4.06$, $SD = 0.71$) were judged as significantly more dominant than faces seen from the front ($M = 3.62$, $SD = 0.75$), $p < .001$. The differences between faces seen from below and from above were not significant, $p = .702$. When faces had a direct gaze they were significantly judged as more dominant ($M = 4.47$, $SD = 0.55$) than when faces had averted gaze ($M = 3.38$, $SD = 0.85$). Male faces were judged as significantly more dominant ($M = 4.53$, $SD = 0.67$) than female faces ($M = 3.33$, $SD = 0.65$).

4.9.2 Physical Strength Judgments (N=71). Our results showed a main effect of head position, $F(2, 140) = 10.63$, $p < .001$, np2 = .132). We also had an effect of gaze direction, $F(1, 70) = 38.68$, $p < .001$, $n_p^2 = .356$. Face gender also showed a significant effect, $F(1, 70) = 375.33$, $p < .001$, $n_p^2 = .843$ – see footnote 14. Again, we were able to find an interaction between head position and gaze direction, $F(2, 140) = 3.3.44$, $p <.035$, $n_p^2 = .047$. Direct gaze faces seen from below ($M = 4.39$, $SD = 0.68$) position were judged as significantly stronger than faces seen from the front ($M = 4.22$, $SD = 0.55$, $p = .028$) and from above ($M = 4.16$, $SD = 0.53$, $p = .003$). There were not significant differences between faces seen from the front and from above, $p = .281$. With gaze averted there were significant differences between faces seen from below ($M = 4.19$, $SD = 0.64$) and from above ($M = 3.87$, $SD = 0.55$), $p = .001$. Additionally, faces seen from frontal ($M = 4.09$, $SD = 0.55$) and from above were significantly different, $p < .001$. Faces seen from below and from the front did not show significant differences, $p = .091$.

Moreover, we found an interaction between head position and gender, $F(2, 140) = 7.99$, $p = .001$, $n_p^2 = .102$. However, we did not find significant differences on judgments of male faces when seen from below ($M = 5.36$, $SD = 0.73$), from the front ($M = 5.30$, $SD = 0.71$) and from above ($M = 5.22$, $SD = 0.73$), *all* $p_s > .05$. Nonetheless, female faces seen from below ($M = 3.22$, $SD = 0.93$) were significantly judged as physically stronger than when they were seen from the front ($M = 3.01$, $SD = 0.76$, $p = .005$) and from above ($M = 2.81$, $SD = 0.70$, $p < .001$). Faces seen from the front were significantly considered as physically stronger than faces seen from above, $p < .001$.

We did not find an interaction between gaze direction and gender, $F(1, 70) = 1.99$, $p = .163$, $n_p^2 = .028$. Furthermore, the interaction between head position, gaze direction and gender was not significant, $F(2, 130) = 0.171$, $p = .843$, $n_p^2 = .002$.

[14] Faces seen from below ($M = 4.30$, $SD = 0.63$) were judged as physically stronger than faces seen from the front ($M = 4.15$, $SD = 0.51$, $p = .031$) and from above ($M = 4.02$, $SD = 0.51$, $p < .001$). Faces seen from the front were also judged as stronger than faces seen from above, $p = .002$. Direct gaze faces ($M = 4.26$, $SD = 0.49$) were judged as significantly stronger than averted gaze faces ($M = 4.06$, $SD = .50$), $p < .001$. Male faces ($M = 5.30$, $SD = 0.63$) were seen as significantly stronger than female faces ($M = 3.01$, $SD = 0.73$).

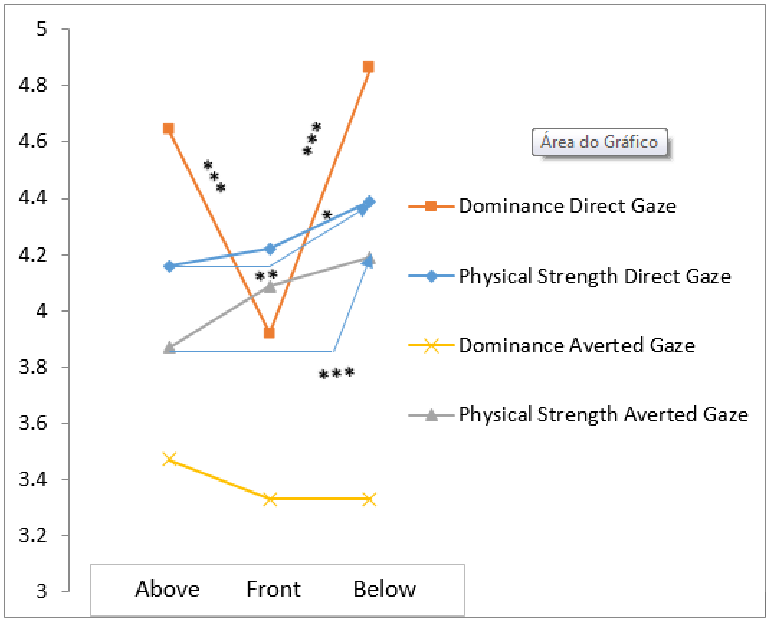

Figure 4.4: Judgments of Dominance and Physical Strength by gaze and head position - Study 2. * p < .05, ** p < .01, *** p < .001.

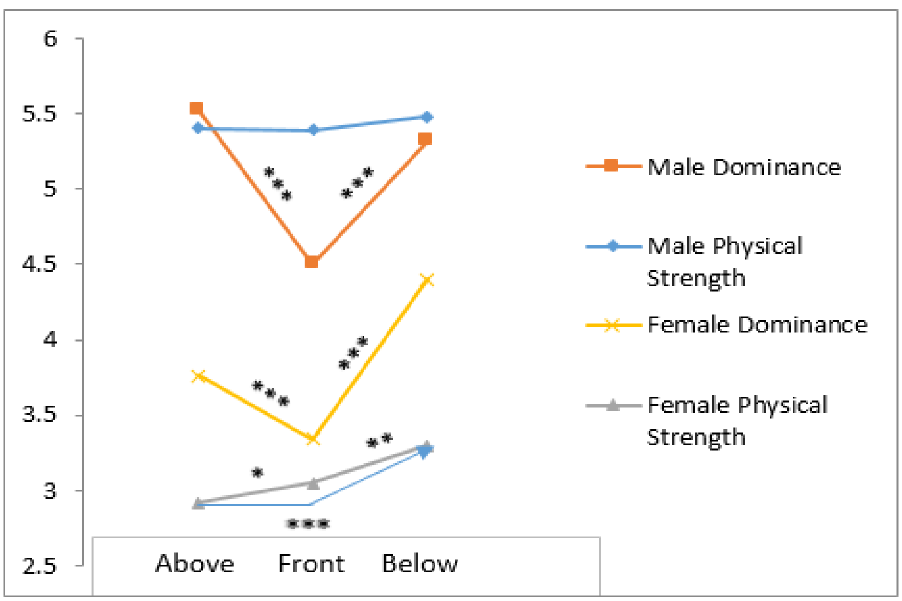

Figure 4.5: Judgments of Dominance and Physical Strength with direct gaze by gender and head position – Study 2. * p < .05, ** p < .01, *** p < .001;

4.10 Discussion

In contrast to study 1, we found some dissimilarities between dominance and physical strength judgments. Dominance judgments showed a very similar pattern to the one present in study 1. Faces seen from below or from above with direct gaze were considered more dominant than faces seen from the front. Physical strength judgments were also influenced by head position and gaze. However, a different pattern occurs for physical strength judgments. Physical strength judgments show a more linear pattern. In the direct gaze condition, we can see that faces are increasingly judged as stronger as head position goes from above to below. Moreover, for male faces we did not find significant different differences for head position.

In sum, dominance shows the same pattern as in study 1. Judgments of dominance are stronger with direct gaze and when faces are seen from below and above. However, physical strength shows a linear effect: it increases from faces seen from below to faces seen from above. Given the somehow different patterns between dominance and physical strength judgments in study 2 compared with study 1, we did a third study where we asked only for judgments of physical strength to get more evidence on how physical strength changes according to gaze and head position.

4.11 Study 3

4.12 Method

4.12.1 Participants. We recruited 65 participants (35 Male, M_{age}=35.86). These participants were also recruited through Amazon Mechanical Turk (Buhrmester, et al., 2011). Again, we paid $1.75 USD to each participant.

4.12.2 Materials. They were the same from study 1 and 2.

4.12.3 Design and Procedure. As in studies 1 and 2, data were collected online, using Qualtrics (www.qualtrics.com). The design and procedure was very similar to studies 1 and 2. The main difference was that we asked only for physical strength judgments.

4.13 Results

4.13.1 Physical Strength Judgments. Head position showed a marginal effect, $F(2, 128) = 2.84$, $p = .062$, $\eta_p^2 = .042$ There was a main effect of gaze direction, $F(1, 64) = 30.93$, $p < .001$, $\eta_p^2 = .326$. Gender showed significant differences on strength judgments, $F(1, 64) = 341.12$, $p < .001$, $\eta_p^2 = .842$ – see footnote.[15]

There was also an interaction of head position and gaze direction, F $(2, 128) = 4.57$, $p = .012$, $\eta_p^2 = .067$. In judgments of direct gaze targets, faces seen from the below ($M = 4.33$, $SD = 0.50$) position angle were judged as significantly stronger than faces seen from a frontal ($M = 4.12$, $SD = 0.43$) position, $p = .001$. Faces seen from below and above ($M = 4.22$, $SD = 0.69$) positions did not have significant differences, $p = .178$. There were not significant differences between faces seen from frontal and above positions, $p = .120$. When the targets' gaze was averted, there were not significant differences across the three positions, *all* $p_s > .05$.

Head position and gender also interacted, $F(2, 128) = 5.11$, $p = .008$, $\eta_p^2 = .074$. Nonetheless, judgments of male faces did not show significant differences when seen from below ($M = 5.27$, $SD = 0.65$), from the front ($M = 5.22$, $SD = 0.62$) and from above ($M = 5.28$, $SD = 0.82$), *all* $p_s > .05$. However, female faces seen from below ($M = 3.11$, $SD = 0.73$) were significantly judged as stronger than when seen from the front ($M = 2.91$, $SD = 0.73$, $p = .002$) and from above ($M = 2.88$, $SD = 0.85$, $p = .003$). Faces seen from the front and from above did not show any meaningful differences, $p = .603$.

We did not find an interaction between gaze and gender, $F(1, 64) = 0.36$, $p = .553$, $\eta_p^2 = .006$. The interaction between head position, gaze and gender was also not significant, $F(2, 128) = 2.16$, $p = .109$, $\eta_p^2 = .033$.

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[15] Our pairwise comparisons showed that faces seen from below ($M = 4.19$, $SD = 0.44$) were considered as stronger than faces seen from the front ($M = 4.07$, $SD = 0.44$), $p = .010$. However, faces seen from below were only marginally seen as stronger than faces seen from above ($M = 4.08$, $SD = 0.65$), $p = .081$. There were not significant differences between faces seen from above compare to faces seen from the front, $p = .861$. Target faces with direct gaze ($M = 4.22$, $SD = 0.46$) were judged as significantly stronger than target faces with averted gaze ($M = 4.00$, $SD = 0.50$), $p < .001$. As expected, male faces ($M = 5.26$, $SD = 0.64$), were evaluated as physically stronger than female faces ($M = 2.97$, $SD = 0.71$), $p < .001$.

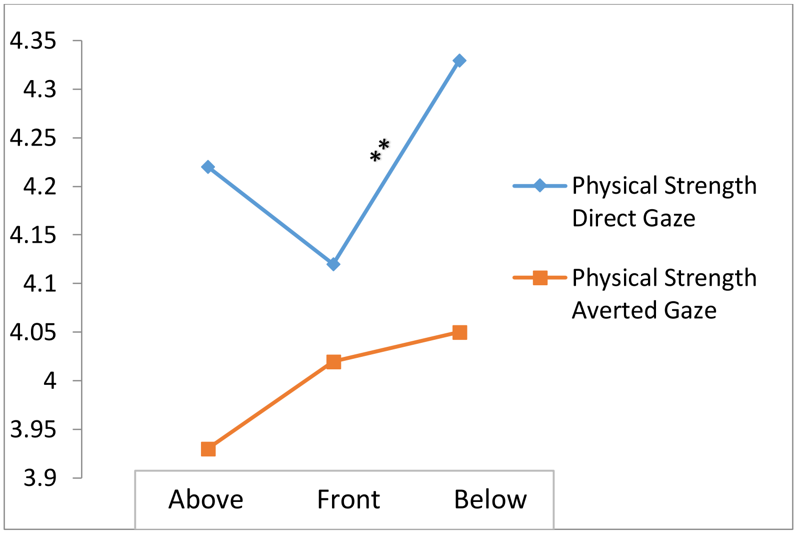

Figure 4.6: Judgments of Dominance and Physical Strength by gaze and head position - Study 3. * p < .05, ** p < .01, *** p < .001.

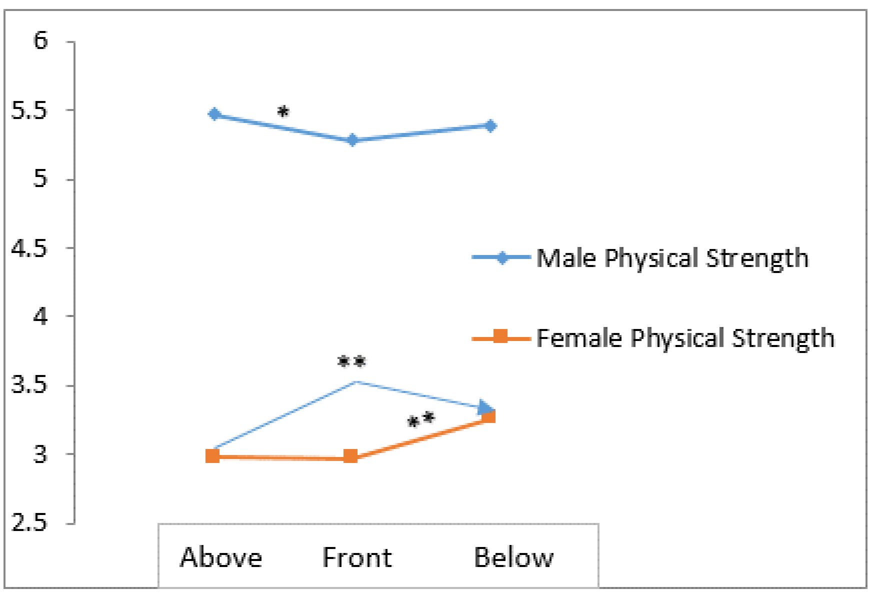

Figure 4.7: Judgments of Dominance and Physical Strength with direct gaze by gender and head position – Study 3. * p < .05, ** p < .01, *** p < .001;

4.14 Discussion

As in the previous studies, head position and gaze direction influenced physical strength judgments. In Figure 4. and Figure 4. we can see that physical strength shows a more similar pattern to one of dominance judgments seen in studies 1 and 2. Generally, we found that faces seen from below and above with direct gaze are judged as physically stronger. It seems that judgments of physical strength have a quadratic effect. The judgments of physical strength are high in faces seen from above, then physical strength decreases for faces seen from the front, and then it again increases for faces seen from below. Because of some differences in the pattern of physical strength through the three studies, we combined the data of our three studies in order to see whether the overall patterns of dominance and physical strength judgments are similar or not.

4.15 Combined Analysis of Studies 1-3

Studies 1 – 3 used the same design, materials, and dependent variables. Results were largely, but not completely, identical. To achieve the best estimate, we ran an analysis on the combined datasets from all three studies.

4.16 Method

4.16.1 Participants. We had in total 295 participants from studies 1-3 (172 female, M_{age}=32.18, *SD* = 11.16).

4.16.2 Design and Procedure. We used the means of each participant for each trait dimension, physical strength and dominance. The design of the study was: 2 (Head from above vs. front vs. below, within) x 2 (judgment: physical strength vs. dominance, between) x 2 (gaze: direct vs. averted, within) x 2 (Gender of the target: male vs. female, within) x 3 (Study 1 vs. Study 2 vs. Study 3 – For Physical Strength judgments) or x 2 (Study 1 vs. Study 2 – For Dominance judgments). Data were analyzed using the SPSS GLM procedure, with study entered as a fixed factor.

4.17 Results

Below, we report estimated means and standard deviations.

4.17.1 Dominance Judgments (N = 114). We found a main effect of head position, $F(2, 224) = 21.73$, $p < .001$, $n_p^2 = .163$. We also found a main effect of gaze direction, $F(1, 112) = 128.34$, $p < .001$, $n_p^2 = .534$. We also found a main effect of gender, $F(1, 112) = 227.61$, $p < .001$, $n_p^2 = .670$ – see footnote[16].

Head position and gaze direction interacted, $F(2, 224) = 38.71$, $p < .001$, $n_p^2 = .257$. When the gaze was direct, faces seen from below (*M* = 4.68, *SD* = 1.497) were judged as significantly more dominant than faces seen from the front (*M* = 3.83, *SD* = 1.27, $p < .001$) and from above (*M* = 4.39, *SD* = 1.36, $p = .002$). Moreover, faces with a direct gaze seen from above were also judged as significantly more dominant than such faces seen from the front, $p < .001$. When the gaze was averted, we did not find significant differences between views from below (*M* = 3.44, *SD* = 1.56), the front (*M* = 3.38, *SD*=1.46), and above (*M* = 3.50, *SD*= 1.95), all $p_s > .050$.

Head position and gender also interacted, $F(2, 224) = 52.81$, $p < .001$, $n_p^2 = .320$. Male faces seen from above (*M* = 4.67, *SD =1.53*) were seen as significantly more dominant than faces seen from below (*M* = 4.47, *SD* = 1.39, $p = .021$) and from the front (*M* = 4.10, *SD* =1.34, $p < .001$). Male faces seen from below were also judged as significantly more dominant than faces seen from the front, $p < .001$. In relation to females, faces seen from below (*M* = 3.65, *SD* = 1.44) were significantly judged as more dominant than faces seen from the front (*M* = 3.11, *SD* = 1.39) and from above (*M* = 3.22, *SD* = 1.31), all $p_s < .001$. Female faces seen from the front and from above did not show significant differences, $p = .157$.

Gaze direction and gender also interacted, $F(1, 112) = 4.92$, $p = .029$, $n_p^2 = .042$. Male faces

[16] Faces seen from below (*M* = 4.06, *SD* = 1.25) and from above (*M* = 3.95, *SD* = 1.20) position were judged as significantly more dominant than faces seen from the front (*M* = 3.61, *SD* = 1.20), all $p_s < .001$. There were no significant differences in perceived dominance between faces seen from below compared to faces seen from above, $p = .156$. Faces with direct gaze (*M* = 4.30, *SD* = 1.05) were significantly more dominant than faces with averted gaze (*M* = 3.44, *SD*= 1.31), $p < .001$. Male faces (*M* = 4.41, *SD* = 1.20) were judged as significantly more dominant than female faces (*M* = 3.33, *SD* = 1.13).

with direct (*M* = 4.87, *SD = 1.20*) gaze were significantly considered as more dominant than with averted (*M* = 3.95, *SD* = 1.58) gaze. The same pattern occurred for female faces with direct (*M* = 3.73, *SD = 1.27*) and averted (*M* = 2.93, *SD = 1.34*) gaze.

Gaze direction interacted with the variable Study, $F(1, 112) = 9.52$, $p = .003$, $n_p^2 = .078$. Faces with direct gaze were seen as significantly more dominant in study 2 (*M* =4.47, *SD* = 1.36) than in study 1 (*M* = 4.13, *SD* = 1.60), $p = .006$. There were not differences for the averted gaze faces, $p = .399$. Head position, gender and study also interacted, $F(2, 224) = 4.91$, $p = .008$, $n_p^2 = .042$. Pairwise comparisons indicated that males were judged to be significantly more dominant when seen from above in study 2 than in study 1. The other mean comparisons did not show any significant differences. All remaining interactions in the combined analysis were not significant, *all* $p_s > .05$. There was not any interaction between head position, gaze direction and gender, $F(2, 224) = 0.077$, p = .926, $n_p^2 = .001$.

4.17.2 Physical Strength Judgments (N = 181). We found a main effect of head position, *F*(2, 356 = 20.59, $p < .001$, $n_p^2 = .130$. We did find a main effect of gaze direction, $F(1, 178) = 87.36$, $p < .001$, $n_p^2 = .329$. We found a gender effect, $F(1, 178) = 812.35$, $p < .001$. For the mean patterns of the main effects see footnote[17].

We had a head position and gaze direction interaction, $F(2, 356) = 10.58$, p < .001, $n_p^2 = .056$. With direct gaze, faces seen from below (*M* = 4.41, *SD* = 0.077) were judged as significantly stronger than faces seen from the front (*M* = 4.12, *SD* = 0.65) and from above (*M* = 4.22, *SD* = 0.77), all $p_s < .001$. Faces seen from above were also seen as significantly stronger than faces seen from the front, $p = .009$. With averted gaze faces seen from below (*M* = 4.16, *SD=0.76*) were judged as physically stronger than faces seen from the front (*M* = 4.02, *SD* = 0.74, $p = .001$) and from above (*M* = 3.94, *SD* = 0.79, $p < .001$). Averted gaze faces seen from the front were also seen as

[17] Faces seen from below (*M* = 4.29, *SD* = 0.70) are significantly stronger than faces seen from the front (*M* = 4.07, *SD = 0.65*) and from above (*M* = 4.08, *SD = 0.74*), all p_s <.001. We did not find significant differences in perceived strength between faces seen from the front and from below, $p = .796$. Faces with direct gaze (*M* = 4.25, *SD* = 0.62) were judged as physically stronger than faces with averted gaze (*M* = 4.04, *SD = 0.65*), $p < .001$. Males (*M* = 5.23, *SD* = 0.82) faces were seen as stronger than females (*M* = 3.06, *SD* = 0.96) faces.

significantly stronger than such faces seen from above, p = .032.

There was also a head position and gender interaction, $F(2, 356) = 28.59$, $p < .001$, $n_p^2 = .138$. Male faces seen from below ($M = 5.28$, $SD = 0.89$) were seen as significantly stronger than faces seen from the front ($M = 5.15$, $SD = 0.88$), $p < .001$. There were not significant differences between male faces seen from below and from above ($M = 5.25$, $SD = 0.98$), $p = .420$. The difference between faces seen from above and the front was also significant, $p = .011$. Female faces seen from below ($M = 3.29$, $SD = 0.89$) were regarded as significantly stronger than faces seen from the front ($M = 2.99$, $SD = 1.00$) and from above ($M = 2.91$, $SD = 1.03$), all $p_s < .001$. Female faces seen from the front were also seen as significantly stronger than faces seen from above position, $p = .013$.

Gaze direction and gender did not interact, $F(1, 178) = 2.66$, $p = .105$, $n_p^2 = .015$. We also did not find an interaction between head position, gaze direction and gender, $F(2, 356) = 2.53$, $p = .081$, $n_p^2 = .014$.

Head position also interacted with study, $F(4, 356) = 4.91$, $p = .001$, $n_p^2 = .052$. An inspection of the means indicated that in study 3, in comparison with study 1, faces seen from below were marginally judged as stronger. In study 2, faces in frontal position, were also marginally considered as physically stronger than in study 1. The rest of the comparisons were also not significant. All the remaining interactions with the analysis of studies 1-3 were not significant, *all* $p_s > .05$.

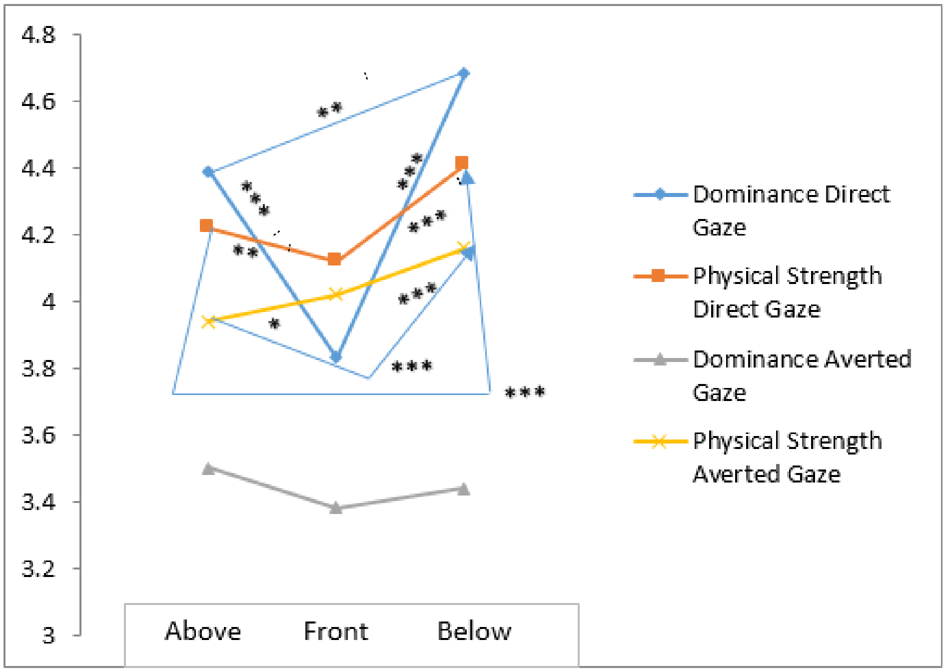

Figure 4.8: Judgments of Dominance and Physical Strength by gaze and head position - Study 3. * p < .05, ** p < .01, *** p < .001.

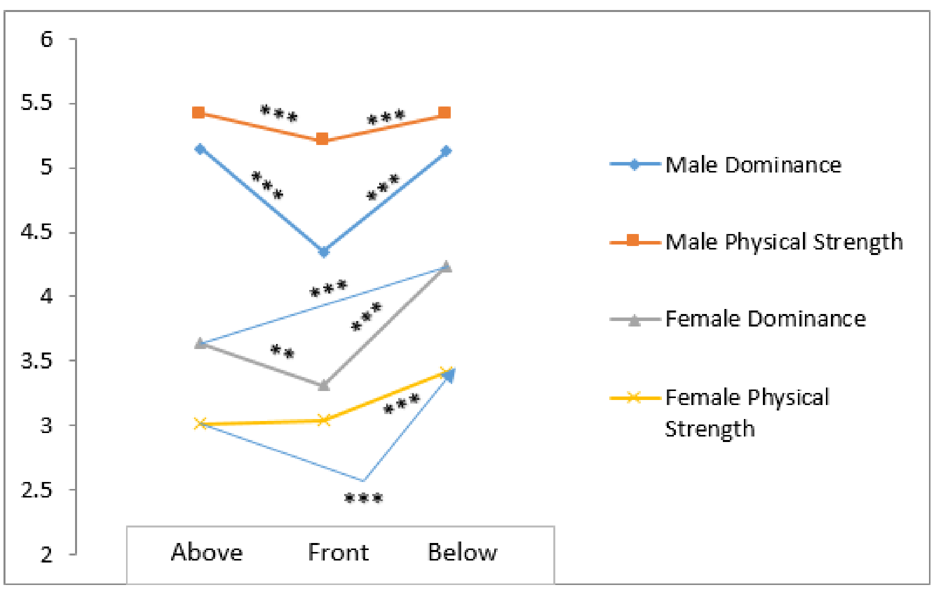

Figure 4.9: Judgments of Dominance and Physical Strength with direct gaze by gender and head position – Combined Studies 1-3. * p < .05, ** p < .01, *** p < .001;

4.17.3 Correlation between dominance and physical strength. Besides the profile of physical strength and dominance across head positions and gaze directions, we also investigated whether there was any interrelation between dominance and physical strength judgments. For this purpose, we ran Pearson correlations. We aggregated judgments of dominance and strength for each picture across all participants; thus picture became the unit of analysis. The correlations were significant across every head position and gaze direction - see **Table 4.1**Table 4.1. Nevertheless, there are some differences. With direct gaze, we see that judgments of dominance and physical strength were more correlated in faces seen from above. When gaze was averted, frontal and above positions showed the highest correlations.

Table 4.1 Correlations between judgments of dominance and physical strength according to head position (from below vs. from the front vs. from above) and gaze (direct vs. averted)

	Direct	Averted
Below	.42***	.49***
Frontal	.68***	.60***
Above	.74***	.60***

*** $p < .001$

4.18 Discussion of the combined analysis

Dominance and physical strength judgments were correlated across all head positions and gaze directions. This adds evidence to other studies that show how physical strength influences dominance (Toscano, Schubert, & Sell, 2014; Windhager, Schaefer, & Fink, 2011). Importantly, dominance and physical strength seem to change in a similar fashion. Nonetheless, gaze direction and head position influenced dominance more than they influenced physical strength. For instance, the differences between facial judgments of direct and averted gaze stimuli are much larger for dominance than for physical strength judgments. Moreover, the profile from above to below position with direct gaze - see **Figure 4.6** - is much more V-shaped for dominance compared to physical strength. In the frontal position, the reduction is much more pronounced for dominance than for physical strength. Thus, the interaction of gaze direction with head position seems to play a more substantial influence for dominance than for physical strength judgments. Therefore, our data suggests that people go beyond physical strength cues while evaluating dominance.

Additionally, one of most intriguing findings of our studies was that dominance and physical strength judgments were very high, particularly for men, when faces were seen from above. Furthermore, the highest correlations between judgments of dominance and physical were observed when heads were bowed. Given that the lowering of the head is usually associated with submission displays (see Mignault & Chaudhuri, 2003) it seems odd that faces in this condition were judged as stronger and more dominant than faces in frontal, and in some cases, even in relation to faces seen from below. We suppose that this may be explained by anger cues recognition. As the literature demonstrated, facial dominance is correlated with anger (Knutson, 1996). Moreover, anger seems to be related to aggression, but also to cooperation (see Sell, Cosmides, et al. 2009). Some authors argue (Sell, Tooby, & Cosmides, 2009) that anger evolved in order to resolve hostilities in favor of the angry person. Therefore, anger, as a mechanism related to physical strength, can be employed to inflict costs on others. More recently, some researchers also posited that the human anger face developed to show cues of physical strength (Sell, Tooby, & Cosmides, 2014). Additionally, it can also be used as a mechanism of social dominance by threatening to refuse to give or even eliminate benefits to others.

Following this line of reasoning, we will explore in a final study whether anger judgments will change in a similar way as dominance and physical strength judgments do. Like in our previous studies, all faces have a neutral expression and will be judged in the same three different angles and two gaze directions (direct versus averted).

4.19 Study 4

4.19.1 Participants. 61 persons (33 female, M_{age} = 34.28) recruited through Amazon Mechanical Turk (Buhrmester et al., 2011) participated in our study. We paid $1.75 USD to each participant.

4.19.2 Materials. Materials were the same as in study 1.

4.19.3 Design and Procedure. It was very similar to the other studies. The only difference was that we asked for judgments of anger. Therefore, the participants had to answer to this question: "How angry is this person?" on a 7-point scale from 1 (not at all angry) to 7 (very angry).

4.20 Results

4.20.1 Anger Judgments. We found a main effect of head position, $F(2, 120) = 65.2$, $p < .001$, $n_p^2 = .719$. There was also a main effect of gaze direction, $F(1, 60) = 10.60$, $p = .002$, $n_p^2 = .148$. We also found a main effect of gender, $F(1, 60) = 317.64$, $p < .001$, $n_p^2 = .817$. For the mean patterns of the main effects see footnote[18].

Head position and gaze direction interacted, $F(2, 120) = 34.71$, $p < .001$, $n_p^2 = .367$. With a direct gaze, faces seen from above (*M*=3.84, *SD*=1.04) were seen as significantly angrier than faces seen from the front (*M* = 2.81, *SD* = 0.98, $p < .001$) and from below (*M*=3.41, *SD*=1.16, $p < .001$). Faces seen from below were also judged as significantly angrier than faces seen from front, $p < .001$. When the gaze was averted, faces seen from above were also considered as significantly angrier (*M* = 3.57, *SD* = 1.09) than faces seen from the front (*M* = 2.97, *SD* = 0.94, $p < .001$) and from below (*M* = 2.76, *SD* = 0.99, $p < .001$). In this condition, however, faces seen from the front were judged significantly angrier than faces seen from below, $p = .001$. Furthermore, we found that there were significant differences within each position angle. Faces seen from below ($p <.001$) and from above ($p =.008$) were judged as angrier when gaze was direct. However, for faces seen from the front, gaze did not influence judgments of anger, $p = .078$.

There was an interaction between head position and gender, $F(2, 120) = 53.78$, $p < .001$, $n_p^2 = .473$. Male faces seen from above (*M* = 4.61, *SD* = 1.19) were considered as angrier than faces seen from the front (*M* = 3.46, *SD* = 1.09) and from below (*M* = 3.58, *SD* = 1.13), *all* $p_s < .001$. There were not significant differences between faces seen from below and from the front, $p =.163$.

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[18] Pairwise comparisons showed that faces see from above (*M* = 3.70, *SD* = 1.00) were judged as angrier than faces seen from the front (*M* = 2.89, *SD* = 0.90, $p < .001$) and from below (*M* = 3.09, *SD* = 1.00, $p < .001$). Faces seen from below were also considered as significantly angrier than faces seen from the front, $p = .007$. Direct gaze faces (*M* = 3.35, *SD* = 0.95) were judged as significantly angrier than averted gaze faces (*M* = 3.10, *SD* = 0.95). Male faces (*M* = 3.89, *SD* = 0.84) were considered as significantly angrier than female faces (*M* = 2.57, *SD* = 0.64).

Female faces seen from above ($M = 2.80$, $SD = 0.98$) were also judged as significantly angrier than faces seen from the front ($M = 2.31$, $SD = 0.80$, $p < .001$) and from below ($M = 2.59$, $SD = 0.97$, $p = .025$). Faces seen from below were also seen as angrier than faces seen from the front, $p < .001$.

We also found an interaction between gaze and gender, $F(1, 60) = 5.14$, $p = .027$, $\eta_p^2 = .079$. When comparing judgments of anger according to gaze, male faces were judged as significantly angrier when gaze was direct ($M = 4.07$, $SD = 1.15$) than when it was averted ($M = 3.71$, $SD = 0.87$). The differences for female faces were only marginal when comparing direct ($M = 2.64$, $SD = 1.13$) with averted gaze ($M = 2.50$, $SD = 0.91$).

The interaction of head position, gaze and gender was only marginal, $F(2, 120) = 2.56$, $p = .083$, $\eta_p^2 = .041$.

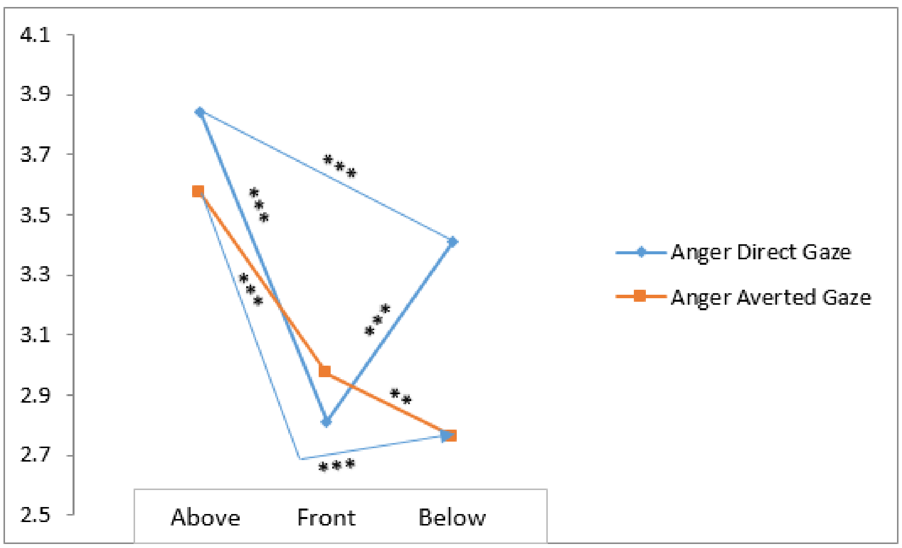

Figure 4.10: Judgments of Anger by gaze and head position - Study 4.
* p < .05, ** p < .01, *** p < .001.

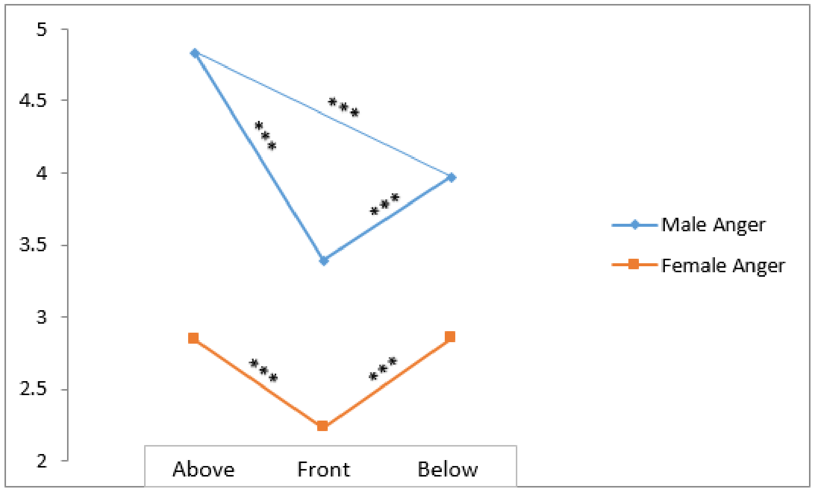

Figure 4.11: Judgments of Anger with direct gaze by gender and head position – Study 4. * $p < .05$, ** $p < .01$, *** $p < .001$;

4.21 Discussion

Our data shows that head position and gaze also influence anger perception. More important for us, anger judgments were higher, in general, when the heads were seen from above and from below. Therefore, it seems that one likely reason for the findings that faces seen from above were judged as more dominant and stronger than heads seen from the front and, even in some cases, in comparison with faces seen from below, may be explained by the enhancing of anger cues when the head is in a downward position.

Curiously, the correlations between anger, dominance and physical strength judgments showed that these judgments were more interrelated in frontal and above positions. This suggests that the high ratings of faces seen from below may be more a product of pride emotion cues (e.g. head tilted back - see Tracy & Robbins, 2007) than anger cues.

Table 4.2: Correlations between judgments of dominance, physical strength and anger according to head position (below vs. frontal vs. above) and gaze (direct vs. averted)

	Direct	Averted	Direct	Averted
	Dominance and Anger		Physical Strength and Anger	
Below	-0.013	.39**	-0.17	0.12
Frontal	0.43**	.60***	0.43**	.50***
Above	.34**	.45***	0.3*	0.13

* p < .05, ** p < .01, *** p < .001;

4.22 General Discussion

In the current chapter, we explored how dominance and physical strength judgments from faces may change depending on gaze direction and head position. We demonstrated that dominance and physical strength are influenced in a similar way by both variables. In general, faces with direct gaze seen from below and above are judged as more dominant and physically stronger than faces seen from the front. In general, averted gaze faces had lower ratings of dominance and physical strength. Additionally, when the gaze was averted, the influence of head position tended to diminish for both judgments.

Importantly, physical strength judgments predicted dominance judgments of direct and averted gaze faces across all head positions. However, the effects of the interaction of gaze direction and head position seem to be somewhat larger on dominance than on physical strength judgments. This may have led to bigger differences across the levels of gaze and head position for dominance compared to physical strength judgments.

The supposed more modest effects of the interaction of gaze and head position on physical strength than on dominance judgments indicate that when people assess others' dominance, they use other cues in addition to physical strength. The relation between physical strength and social dominance, where cues of strength cause the inference of dominance, was and still is a fundamental heuristic to predict social status (Toscano et al., 2014). However, a great number of abilities associated to social dominance such as emotional intelligence, ability to lead and cognitive aptitudes are not necessarily connected to physical strength (Cheng et al., 2013; Henrich and Gil-White, 2001). Thus, this might explain why gaze and head position play a larger role in dominance than in physical strength.

According to the literature, people perceive concrete information (physical strength) and then overgeneralize to abstract social information (dominance trait; Oosterhof & Todorov, 2008; Sell et al., 2009; Toscano et al., 2014; Windhager et al., 2011; Zebrowitz 2011). Gaze and head position are related to processes associated with the display (Darwin, 1972; Mignault & Chaudhuri, 2003) and inference of intentions (Baron-Cohen, 1995), and this may explain that their influence is larger for social (i.e. dominance) than for physical judgments (i.e. physical strength). Gaze seems to play a very important role in social cognition (Argyle, 1981; Macrae et al., 2002) and its interpretation involves the activation of areas of the brain associated with the attribution of mental states to others (Kampe, Frith, & Frith, 2003; Wicker, Perrett, Baron-Cohen, & Decety, 2003). It also seems to convey the intention to communicate (Kampe, Frith, & Frith, 2003). Gaze is also intrinsically linked to cooperation (Bateson, Neetle, & Roberts, 2006). Moreover, head position may be related with displays of supremacy or appeasement that transmit intentions to maximize influence, enter into conflict or maintain social unity (Mignault & Chaudhuri, 2003). Therefore, the way we look at others (i.e. gaze direction) and move our heads (i.e. head position) may signal cues that are more social and abstract (e.g. traits, intentions) in nature which, consequently, may play a greater influence for abstract (e.g. dominance) than physical impressions (e.g. physical strength).

Another interesting finding was the existence of, particularly for men, high ratings of dominance and physical strength when the head was seen from above. Our data showed that this might be related with the enhancement of anger cues when the head is bowed. At first glance, this finding seems to go against the literature which suggests that a head seen from above is associated with obedience (Mignault & Chaudhuri, 2003). However, some studies show that anger expression may be involved with descending movements of the upper face, more specifically, the forehead area (Bassili, 1979). Moreover, anger cues seem to be displayed by a V-shaped downward angle (Aronoff, Woike, & Hyman, 1992; LoBue & Larsoon, 2010). Faces in the above position - see Figure 4.1 - have in the forehead and brow regions a much more marked V-shape than faces in frontal and below positions. Our findings show that the profile of dominance and physical strength across head position and gaze direction might be partly explained by anger cues.

On the whole, our research seems to be consistent with recent studies that suggest that "the face is not a still image frozen in time but rather a constantly shifting stream of expressions that convey different mental states" (Todorov & Porter, 2014, p. 1416). Given the functional role of face evaluation (e.g. Oosterhof & Todorov, 2008), contextual and dynamic cues seem to play a role in trait impressions from faces. Our research indicates that face evaluation may change depending on context. More specifically, dominance and physical strength judgments from faces are modulated by cues such as gaze and head position. In line with this reasoning, recent studies have demonstrated that different images of the same face may induce different trait inferences (Jenkins et al., 2011). More specifically, participants who were asked to rate the attractiveness of a face varied their ratings based on the photo of the face. Ratings of attractiveness showed an enormous variability. There was no consensus in judgments of attractiveness of the same persons when they were seen in different photos. More recently, some authors (Todorov & Porter, 2014) revealed that participants showed a strong variability while judging different expressions of the same person. As a side note, the expressions had an equivalent head angle and lighting. Furthermore, preference for the expression of the same person varied according to the type of context. For instance, certain pictures were preferred when the participants had to select a person to a position of consultant but other pictures were selected more times when perceivers had to decide which one fitted better for a different position (i.e. mayor, facebook profile, villain, dating website). In sum, dynamic cues seem to play an important role in impressions from faces.

4.23 Conclusion

In this chapter, we intended to explore how dominance and physical strength might change according to gaze and head position. Our data show that dominance and physical strength are influenced in similar fashion by gaze direction and head position. Nonetheless, the way gaze and head position interact seems to be more important for dominance than for physical strength judgments. Therefore, facial dominance perception may be the result of additional cues besides strength. Interestingly, anger cues seem to be partly responsible for the pattern of dominance and physical strength judgments along the levels of gaze direction and head position. Moreover, given the changes on the different gaze and head position conditions we also show the dynamic nature of face evaluation. In sum, we find that physical strength and dominance are strongly related across all head positions and gaze directions, but show some differences across the different gaze and head position cues.

CHAPTER V[19]

BODILY ACTIONS INFLUENCE PERCEPTION OF SOCIAL DOMINANCE

5.1 Constricted Postures Polarize Perception of Social Dominance

Power, the ability to control our own and others' resources and outcomes, is an important psychological factor in social relationships (Keltner, Gruenfeld, & Anderson, 2003). Having or lacking power also influences cognitive processes such as information processing (Briñol, Petty, Valle, Rucker, & Becerra, 2007), *disinhibiting* action (Galinksy, Gruenfeld, & Magee, 2003), abstract thinking (Smith & Trope, 2006), consumer behavior (Rucker & Galinsky, 2009), stereotyping (Fiske, 1993) and sensitivity to pain (Bohns & Wiltermuth, 2012).

Power felt by people varies across individuals (Anderson & Berdahl, 2002; Anderson, John, & Keltner, 2012) and situations (Keltner, Gruenfeld, & Cameron, 2003). According to Anderson et al. (2012), individual feelings of power are related to certain personality characteristics. However, the sense of power may also be manipulated through posture or other body manipulations that increase the apparent size of someone, more specifically, through the use of expansive or constrictive postures. Research has started to investigate the cognitive effects of such embodied manipulations of power (Carney, Cuddy, & Yap, 2010; Huang, Galinsky, Gruenfeld, & Guillory, 2010; Yap et al., 2013).

Literature shows that hierarchies exist in every human society (Fiske, 1992; Friesen et al., 2014). A crucial aspect of having or not having power is how cues of dominance in others and possible hierarchies are processed, and a rich literature suggests that embodied power should

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[19] This chapter is based on the paper Toscano, H., Schubert, T. W., & Waldzus, S. (2014). *Constricted Postures Polarize Perception of Social Dominance*. Manuscript submitted to publication.

influence the way people process further dominance cues. However, the role of embodied power in perceiving social hierarchies has not been tested. Here we provide evidence for the idea that the way we perceive differences in social dominance may be influenced by our body posture. We will test this by studying how different body postures affect the perception of facial dominance.

5.2 Power and Information Processing

A rich literature has explored how power influences the perception and judgment of others. Feelings of power induce people to be less attentive to others ranking below them on the social ladder (Fiske, 2010). The lack of motivation to individuate information leads them to stereotype more (Fiske & Dépret, 1996). Power influences reasoning through reduction of attention (Fiske, 1993). Some studies showed that persons in a powerful role are less accurate in making judgments of others (Ebenbach & Keltner, 1998). Powerful people are usually more self-centered (Galinksy, Magee, Inesi, & Gruenfeld, 2006) and indifferent to what others think about them (Snodgrass, 1992). This makes them more focused and oriented toward goals (Guinote, 2007). Powerful people tend to ignore information that is not "central" to their task. According to some authors (Anderson, Keltner, & John, 2003) powerful people show less empathic concern than powerless people (but see Côté et al., 2011; Schmid Mast, Jonas, & Hall, 2009).

Furthermore other authors have found (e.g. Smith & Trope, 2006) that high-power individuals are more psychologically distant from others than low-power individuals. Additionally, this distance increases abstract thought. Therefore, powerful individuals tend to be more focused on the ‘big picture’ and general information. Low-power persons are more prone to search for detailed information in order to gain knowledge about others. In a demonstration of this effect in real-world environments (e.g. September 11) powerful individuals tend to give more abstract descriptions of the incidents and show less concern about others than less powerful individuals (Magee, Milliken, & Lurie, 2010). More recently, Hogeveen, Inzlicht, and Obhi (2014) investigated whether high power and low power persons differ in the activation of brain regions when they see another person executing an action (i.e. motor resonance). Recent studies demonstrated that the ability of our brain to resonate with other people's actions is of central importance to understand and empathize with others (Decety & Sommerville, 2009). Hogeveen et al. (2014) found that powerful participants had less motor resonance than powerless participants. This study suggests that power is associated with a more superficial processing of information about others.

Conversely, powerless individuals have less sense of control (Fiske & Dépret, 1996). Additionally, they tend to be more accurate in their judgments. They are better in inferring emotions of others (Kraus, Côté, & Keltner, 2010) and in putting themselves in others' shoes (Galinsky et al., 2006). They seem to be more active in trying to understand others' feelings and behaviors. Brain regions related with mentalizing or thinking about how others feel become more active in powerless than in powerful people. Muscatell et al. (2012) were able to demonstrate this with participants of lower social economic status, who activated mentalizing circuitry areas more strongly. High social economic participants showed less activation in areas involved in thinking about how others think and feel. This reveals that low power individuals may show more empathy and accuracy when judging others.

5.3 Power and Processing of Status and Dominance Information

The cognitive differences between powerful and powerless individuals are especially pronounced in the domain of cognition about hierarchies. In some primate societies, low-status members tend to follow the gaze of others in a more vigilant way than high-status members, who tend to be more discriminative, shifting their attention more often to other high-status monkeys (Shepherd, Deaner, & Platt, 2006). Moreover, low power primates seem to represent social hierarchies in a more complex manner (Chance & Jolly, 1970). In humans, less dominant individuals are more sensitive to cues of dominance (e.g. Watkins et al., 2010) than more dominant individuals. Using height as a characteristic of male dominance, Watkins and collaborators (2010) showed that shorter men (i.e. less dominant persons) were more responsive to cues of facial dominance, whereas powerful men (i.e. taller ones) were less sensitive to cues of facial dominance. Additionally, men who rated themselves as less dominant were more prone to respond to cues of dominance than men who rated themselves as high in dominance (Watkins, Jones, & DeBruine, 2011).

Consistent with this, participants of lower economic status also show more activation of the amygdala than higher economic status participants when processing angry looking faces

(Muscatell et al., 2012). Fessler and Holbrook (2013) showed that a bodily manipulation (i.e. physical incapacitation) increases the perceived dominance of an angry person. In two studies, they were able to demonstrate that participants who were not able to move freely tended to consider the stimuli as bigger and as having more muscularity. Given that angry facial expressions are positively associated with judgments of dominance (e.g. Sell, Cosmides, & Tooby, 2014), this adds evidence to the notion that powerless persons respond differently to facial dominance cues.

In sum, having power not only affects information processing in general, but also processing of status and dominance information in particular. In particular, it appears to change the processing of the upper end of the dominance dimension.

5.4 Embodiment of Power

Empirical evidence has shown that feelings of power can be altered with changes in posture. In a meta-analysis, Hall, Coats and LeBeau (2005) established that postures that increase apparent size are an effective way of communicating status and power. One of the behaviors that is correlated with increase of size is postural expansion (i.e. postures that make the body seem larger, e.g. spreading the legs and arms; upright posture). As a result, people attribute more power to others who are in an expanded posture than to those who show a constricted posture (e.g. body more closed inward; reduced space between legs; a more curved upper-body). Tiedens and Fragale (2003) found that a confederate's posture caused the participants to more often act in a complementary way. Participants facing a confederate sitting in an expanded posture were more likely to constrict, while those facing a confederate sitting in a constricted posture were more likely to expand. Participants seemed to have taken on these complementary postures without conscious intent.

In sum, the expansiveness of others' postures is a strong dominance cue and has behavioral consequences in the perceivers. In addition, however, such postures apparently feedback a sense of power to those that behave in this way. Some studies (Schubert, 2004; Schubert & Koole, 2009) found that a fist gesture increased the availability of the concept of power for male participants, and led men to see themselves as more powerful. Likewise, posing in an expanded way instills a sense of power (Bohns & Wiltermuth, 2012; Carney, Cuddy, & Yap, 2010; Huang, Galinsky, Gruenfeld, & Guillory, 2010; Yap et al., 2013). These studies demonstrated that participants in an expansive posture (versus a constrictive posture) felt more powerful. Additionally, participants in an expanded posture increased their approach behavior, were more prone to risk-taking behaviors, showed more tolerance against stress, and more tolerance of pain. A powerful posture also increases levels of testosterone and diminish levels of stress hormones (e.g. cortisol) in comparison with a constrictive body posture (Carney et al., 2010). In a similar way, constricted posture also increases feelings of stress after negative feedback (Riskind & Gotay, 1982).

Given that power can lead to a reduction of empathy, indifference and ignoring of others (see Fiske, 2010), reduction in response to cues of dominance (Fessler & Holbrook, 2013; Muscatell et al., 2012; Watkins et al., 2010; Watkins, Jones, DeBruine, 2011), while an expansive posture can make people feel more powerful, we hypothesize that expansiveness of posture can have a direct effect on how we perceive dominance cues from others and the differences among them. We focus on facial cues of dominance, a thoroughly investigated topic. Dominance is one of the two main dimensions on which faces are judged (along with trustworthiness, Oosterhof and Todorov, 2008; Sutherland et al., 2013). Judgments of facial dominance rely primarily on cues predominant in faces of physically strength (Toscano, Schubert, & Sell, 2014; Windhager, Schaefer, & Fink, 2011). People largely agree on which faces are dominant and which are not, and Oosterhof and Todorov (2008) were able to relate dominance judgments to changes in facial shapes represented in a 3D model of the human face. This allowed them to computer-generate faces that are varying systematically on the dominance dimension.

We predict that individuals in an expansive posture will not only feel more powerful, but also be less sensitive to cues of facial dominance, and therefore perceive less difference between faces objectively differing in facial dominance. Given their indifference in judging others in general and dominance cues in particular, we expect that participants in a powerful posture will tend to see fewer differences across the levels of facial dominance. In comparison, powerless persons are more sensible to dominance which may lead them to judge the different levels of dominance with more precision (Fiske, 2010). Therefore, powerlessness will be associated with seeing more differences between the levels of facial dominance.

5.5 Overview of the Current Study

We investigate this hypothesis by manipulating the posture of participants while they judge faces of others. Using a manipulation of posture adapted from Tiedens and Fragale (2003), we test whether a powerful versus a submissive posture can influence the differences perceived between the levels of facial dominance. For this study, participants were asked to judge the social dominance of faces. The faces came from the database of Oosterhof and Todorov (2008). We selected pictures that corresponded to the three different levels of facial dominance: low, medium and high dominance.

5.6 Method

5.6.1 Participants. We tested N = 198 participants (137 female, Age: M = 21.01, SD = 4.44). All were students from ISCTE-IUL, an university in Lisbon, Portugal. They were compensated with 5 € vouchers.

5.6.2 Materials. We used computer-generated faces developed by Oosterhof and Todorov (2008; see Figure 1). The faces were created with FaceGen software (FaceGen Modeller program version 3.1, http://facegen.com). We chose the faces according to the mean ratings of dominance attributed to them (see Todorov Database - http://tlab.princeton.edu/databases). We selected 60 computer-generated faces (dimensions 400 x 400 pixels). Each face selected corresponded to one of these levels of dominance: low, medium or high dominance. Therefore, we had 20 low dominant faces (Mean values of dominance based on the Todorov Database Judgments M = 3.36, 20 medium dominant faces, M = 5.08, and 20 high dominant faces, M = 7.15, see **Figure 5.1**). In addition, we used 18 abstract paintings by Kandinsky (see Tiedens & Fragale, 2003) before the judgments of dominance from faces.

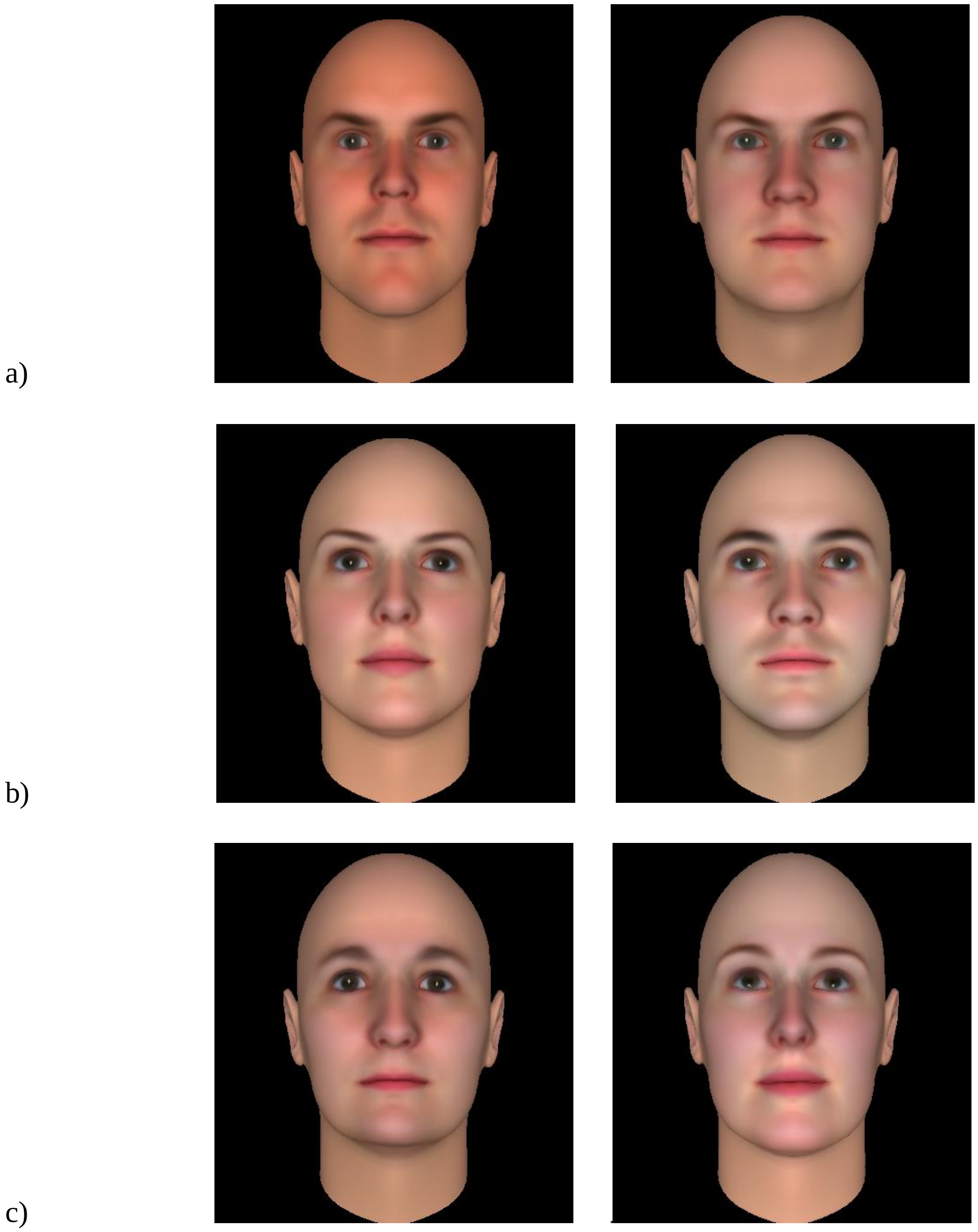
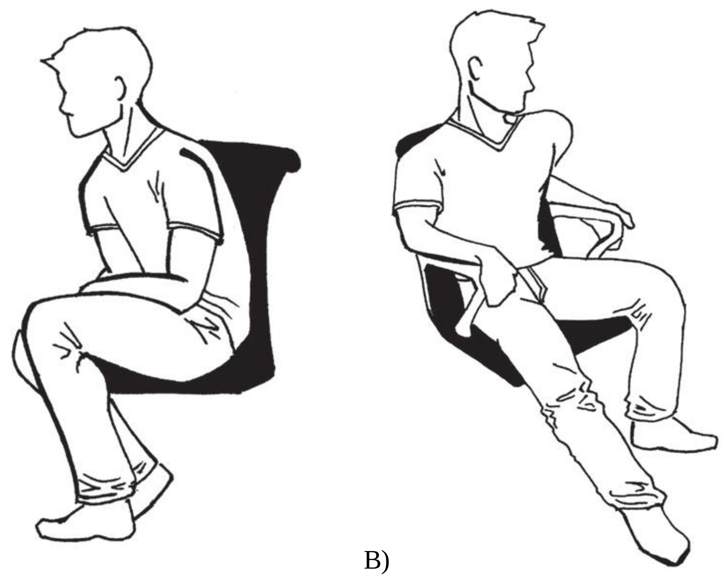


Figure 5.1: Examples of pictures used in the experiment: a) high dominant faces; b) medium dominant faces; c) low dominant faces.

5.6.3 Design and Procedure. Upon arrival to the laboratory, participants were told that the study was a marketing test of ergonomic chairs (Huang, et al., 2010), and were instructed to be seated in specific postures. The reason we gave was that we were interested in studying the comfort felt in various postures while using an ergonomic chair. The manipulation of postures was adapted from Tiedens and Fragale (2003) – see **Figure 5.2**. In the expansive/powerful posture condition, we asked the participants to put both arms on the armrests of the ergonomic chair, to spread their legs and to raise their shoulders and head. In the constrictive/powerless posture, participants were told to put their legs closed, to curve their upper-body and put together the hands between their legs. We asked to always maintain that posture during the experiment except when they needed to raise a hand to type on the keyboard.



A) B)

Figure 5.2*:* Bodily Postures: (A) Constrictive/Powerless and (B) Expansive/Powerful.

After the instructions related to postures, participants completed a task on the computer. In order to distract from the true goal of the experiment, participants were told to look at a screen which displayed, during the first three minutes of the experiment, 18 abstract paintings. Following this, participants judged 60 computer-generated faces twice. Above each face, there was the question "How dominant is this person?", and below the face there was a scale from 1 (not at all dominant) to 9 (dominant). Participants indicated their choice by pressing the corresponding number key. Before the dominance judgments, the experimenter gave the participants the instruction that dominance is "how much this person wants to influence other people and how much she or he is able to do so". After the computer task, participants had to complete a questionnaire. The first three questions were related to the market analysis of ergonomic chairs: "How comfortable is this chair?", "What is the likelihood that you would buy this chair?" and "How much would you pay for this chair?". As a manipulation check of the posture (Fischer et al., 2011) we asked participants to what extent they felt powerful, strong and superior using a scale from 1 (not at all) to 7 (extremely). Participants had to maintain the postures until the end of the study.

In sum, the design of the study was a 2 (Posture: Expansive vs. Constrictive, between) x 3 (Levels of Dominance: Faces of high dominance vs. Faces of medium dominance vs. Faces of low dominance, within).

5.7 Results

5.7.1 Feelings of Power.

We analyzed only data from 197 participants as one participant did not answer to the questions related to measures of power. Participants in the powerful posture ($M = 4.44$, $SD = 0.76$) felt more powerful than participants in the submissive posture ($M = 3.66$, $SD = 0.92$), $F(1, 195) = 42.00$, $p < .001$, $n_p^2 = .177$.

5.7.2 Dominance Judgments.

Because we showed multiple targets to a sample of participants, we used linear mixed models (also known as hierarchical linear models) to analyze the effect of body posture (dominant vs. submissive) and level of facial dominance on judgments of dominance (Judd, Westfall, & Kenny, 2012). The units of analysis were the observations of dominance judgments. However, participant ($N_1 = 198$) and target face ($N_2 = 60$) were added as groupings of the overall 23760 observations (note that each face was presented 2 times to each participant) in a cross-classified multilevel model. First, using the MIXED command in SPSS 22, we modeled the random effects to control for possible interdependence of the data depending on participant and target face. In this model we allowed the intercepts to vary randomly between participants and between target faces.

We also allowed the slopes of the manipulation of body posture (effect coded -1/2 for low power and +1/2 for high power posture[20] and entered using the WITH command) to vary randomly between target faces and the slopes of the different levels of face dominance (entered as three-level factor using the BY command) to vary randomly between participants.

After controlling in this manner for interdependence in the data, we added the fixed effects testing our hypothesis. More specifically, we tested fixed effects of the manipulation of body posture (contrast coded as described above), the differences between levels of facial dominance, as well as their interaction. As we had three levels of dominance in the stimulus material, we coded the level of dominance variable into two contrast variables. The first contrast tested highly dominant faces (coded as +2/3) against both medium dominant faces and low dominant faces (both coded as -1/3). The second contrast tested medium dominant faces (coded as +1/2) against low dominant faces (coded as -1/2). To assure that this second contrast was orthogonal to the first contrast, we coded highly dominant faces as 0. All fixed effects predictors were entered using the WITH command in order to preserve the intended effect coding. See **footnote 20**.

Overall, the model had 11 estimable parameters: (1) the overall intercept, (2) the overall residual, (3-7) five fixed factors (three main effects and two interactions), and (8-11) four random effects (the intercept and slopes varying for each participant and target face). For the model estimation we used Restricted Maximum Likelihood Estimation (REML) with the default SPSS configurations and using Variance Components Matrices for the random effects. Thus, we did not estimate possible correlations between the 8 different random parameters, as it would have increased the complexity and necessary computer power of the model enormously.

Inspection of the fixed effects model showed that there was no overall main effect of posture on judgments of facial dominance: Participants in a dominant posture did not differ from persons in a submissive posture regarding the overall level of their judgments of facial dominance, $F(1, 196.377) = 0.052$, $p = .82$. Not surprisingly, there was a main effect of the first contrast of facial dominance (high versus medium/low dominant faces), $F(1, 115.677) = 427.25$, $p < .001$,

[20] All contrasts used in the following analyses are scaled such that they span a unit of 1 in order to ease interpretation of the reported *B* statistics. For instance, because we code conditions as -1/2 vs +1/2 rather than the usual -1 vs +1, the B of this effect and its interactions directly expresses the change in dominance judgments on the used scale.

which positively predicted dominance judgments (B = 2.31 [2.091, 2.534],[21] SE = 0.112). Thus, highly dominant faces were judged on average 2.3 scale units more dominant than the other faces combined. The main effect of the second contrast was also significant, $F(1, 115.677) = 61.57$, $p < .001$. Medium dominant faces were judged as about 1 scale point more dominant that low dominant faces, (B = 1.01 [0.758, 1.270], SE = 0.129). **Figure 5.3** depicts the means.

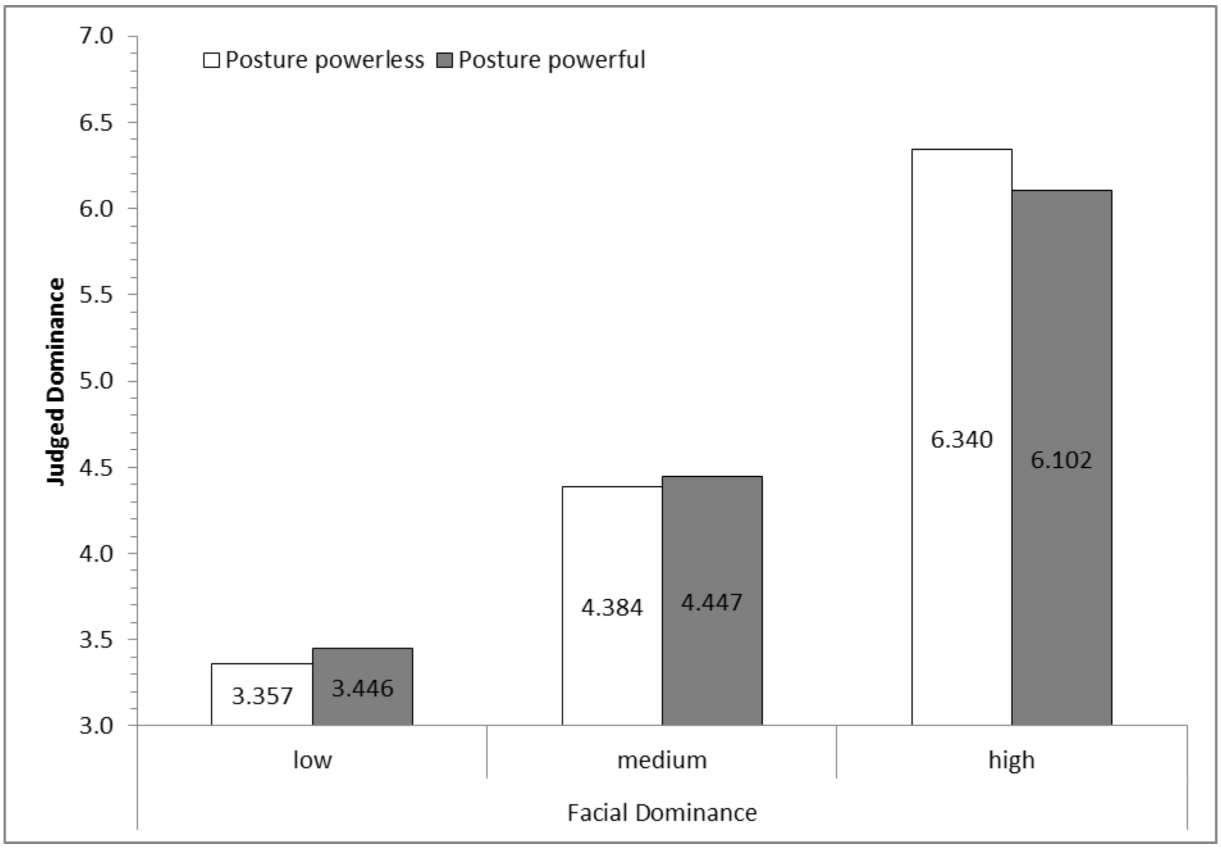


Figure 5.3: Judged Dominance of Targets Depending on Bodily Posture During Judgment and Facial Dominance of Target (Estimated Means).

Importantly, the predicted two-way interaction between body posture and the first contrast was significant, $F(1, 372.91) = 5.71$, $p = .017$. As indicated by the parameter estimate of this interaction (B = -0.31 [- 0.572, -0.056], SE = 0.131), the difference between dominance judgments

[21] [a,b] reports a 95% confidence interval around the estimated parameter.

of high power faces and other faces was smaller in the powerful body-posture condition (Δ = 2.156 [1.900, 2.412]) than in the powerless body-posture condition (Δ = 2.470 [2.212, 2.726]). **Figure 5.4** visualizes the mean and confidence interval of this difference, and how it is derived from the difference between the posture conditions on the one hand, and the difference between the kinds of targets on the other hand.

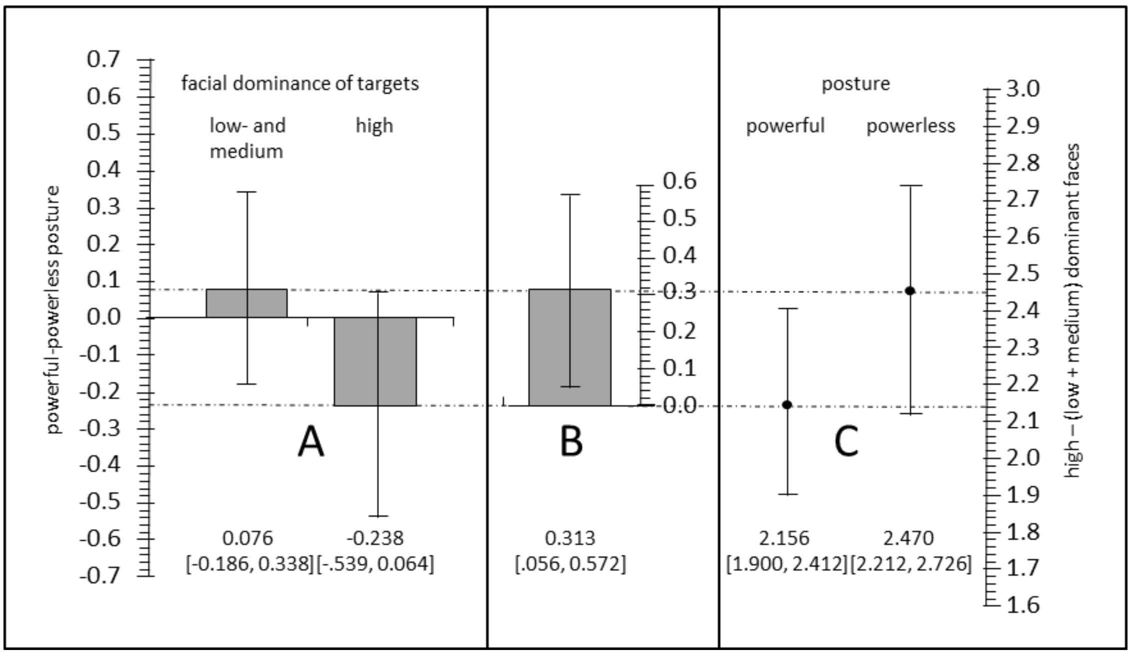


Figure 5.4: Differences (Means and 95% CIs) in Facial Dominance Judgments caused by Interacting Facial Dominance (Contrast 1) and Bodily Postures. Panel A shows difference (Means and 95% CISs) in dominance judgments due to posture: Left bar shows low and medium dominant faces combined, right bar shows dominant faces; high values indicate higher judgments in powerful posture. Panel C shows difference between faces of high facial dominance minus faces of low and medium facial dominance. Left dot marks the powerful posture condition, right dot marks powerless posture condition. The bar in Panel B visualises the difference between the differences in depicted in Panels A and C and its 95% CI. The dotted horizontal lines show how the difference in Panel B results from the differences between conditions in A and C.

The interaction between posture and the *second* contrast coding facial dominance was not significant, $F(1, 372.91) = 0.029$, $p = .86$, indicating that the posture manipulation had a specific effect on the differentiation between highly dominant faces and other faces, but not on the differentiation between medium dominant and low dominant faces.

The model estimates revealed that there was substantial interdependence between data of the same participant and of the same target face. Three out of the 4 estimated random effects of intercepts and slopes were significant (*Wald Z'*s > 50, *p*'s < .001). The only exception was the random effect of body posture (*Wald* Z = 0.43, *p* = .664) for target faces. Thus, the body posture main effect did not vary randomly beyond the interaction depicted above.

In summary, these results show that body postures have an effect on the sensitivity to variation between highly socially dominant targets and others, but not necessarily on levels of perceived dominance as such. A powerless posture led to a polarization of judgments regarding faces rated highly dominant and less dominant.

5.7.3 Sense of Power Mediating Posture

To investigate the process further, we conducted a mediated moderation analysis using feelings of power as the mediator of manipulated body posture.

5.7.3.1 Replacing posture by sense of power in the multilevel model. First, we ran the same multilevel analysis as before, but replaced the effect-coded posture variable with grand-mean centered perceived feelings of power variable. This only tests whether the mediator affects the dominance judgments in interaction with facial dominance of the targets. As in the prior analyses, participants and target faces were entered as grouping variables and the intercepts for participants as well as for target faces were allowed to vary randomly. Moreover, the slope of levels of face dominance was allowed to vary randomly between participants and the slopes of grand mean centered perceived power were allowed to vary randomly between faces. The covariance parameter estimates indicated that this time all random effects were significant (*Wald Z'*s > 2.65, *p'*s < .008). As fixed effects we found again the significant main effects of the first, *F*(1, 114.98) = 426.58, *p* < .001, and the second contrast, *F*(1, 114.98) = 61.69, *p* < .001.

The power main effect was not significant, *F* (1, 202.07) = 0.71, *p* = .40 (just as there was no posture main effect in the previous analysis). There was, however, a significant two-way interaction between the first contrast (high dominant faces versus other faces) and perceived power, *F*(1, 377.13) = 11.02, *p* = .001. As predicted, the less powerful the participants felt, the larger the differentiation (i.e., the weight of the contrast) between highly dominant faces and the other faces (*B* = -0.24 [- 0.387, - 0.099], *SE* = 0.073). Consistent with what we found for the posture manipulation, there was no interaction between power and the second contrast (medium dominant faces versus low dominant faces), $F(1, 377.13) = 0.13$, $p = .72$.

5.7.3.2 Mediated Moderation Analysis. Finally, in order to estimate the indirect effect of our mediated moderator model, we aggregated data over stimuli to simplify. We averaged dominance judgments within each target category to three scores for the high, medium, and low dominance faces and continued with participant-level data, treating differences between target faces as within-subjects effects. Following recommendations of Judd, Kenny, and McClelland (2001) for testing within-subjects moderators, we multiplied the first (high vs. medium/low dominant faces 2/3 -1/3 -1/3) and the second (medium vs. low dominant faces 0 -1/2 -1/2) contrast by the estimations of facial dominance and these contrasted dominance judgments were then used as criteria in linear regression analyses. In other words, there were now two dependent variables (DV) that embody the differentiation of judged facial dominance according to the two contrasts (high vs. other and medium vs. low).

In order to test the mediation model, we computed a regression analysis that estimated the indirect effect of body posture on the DV embodying the contrast of high facial dominance vs others (see **Figure 5.5**), mediated by feelings of power. The regression models estimating the effect of posture on feelings of power, $R^2 = .18$, $F(1, 195) = 43.2$, $p < .001$, and predicting the effect of posture and feelings of power on the contrast, $R^2 = .04$, $F(2, 194) = 3.90$, $p = .022$, were both significant. To estimate the indirect effect, we used the SPSS-macro PROCESS (Hayes, 2013, 2014). To achieve more robust estimates and avoid issues that could result from deviations from the normal distribution, we used the bootstrapping method (with 1000 bootstrap samples) with bias-corrected estimates of confidence intervals (95%).

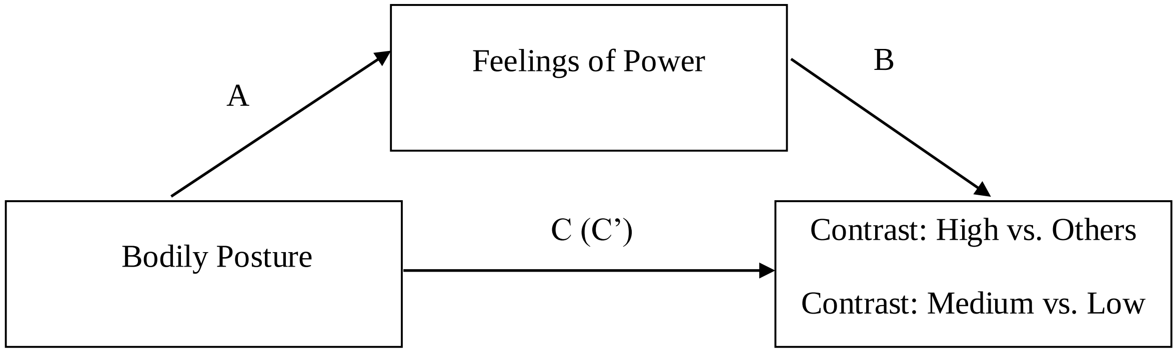


Figure 5.5: Mediated Moderation Model. Dependent Variable is Judged Dominance Multiplied by a Contrast (High vs. Others or Medium vs. Low). For estimates of A, B, C and C' and both contrasts, see Table 1 and 2.

As shown in **Table 5.1**, the effect of the feelings of power on the contrast-multiplied judged dominance (b path) was significant, indicating a moderation of the effect of feelings of power on judgments of facial dominance by the dominance of the target face (high dominant vs. other faces). Consistent with our mediated moderation hypothesis, the indirect effect of body posture via feelings of power on the contrast was significant (a*b: B = - 0.11 [- 0.23, - 0.0004], SE = 0.05).

Table 5.1: Total effect (C) and direct effects of the mediated-moderation analysis with contrast High Dominant vs. Others.

Effect	*B*	*SE*	*t*	*p*	CI
A	0.792	0.121	6.573	<.001	[0.555, 1.030]
B	-0.138	0.067	-2.055	.041	[-0.270, -0.006]
C'	-0.209	0.107	-1.844	.054	[-0.422, 0.006]
C	-0.105	0.125	-0.838	.403	[-0.351, 0.142]

In sum, feelings of power mediated the effect of posture in the interaction with dominance of the target face when dominance judgments of high dominant faces were contrasted with the other two levels (medium and low) combined. The result suggests that taking on an expanded posture (compared to a constricted one) reduces differentiation between higher and other levels of a social hierarchy because it increases one's sense of power – see also **Table 5.2**.

Table 5.2: Total effect (C) and direct effects of the mediated-moderation analysis with contrast Medium Dominant vs. Low.

Effect	B	SE	t	p	CI
A	0.389	0.061	6.495	<.001	[0.271, 0.508]
B	-0.035	0.05	-0.689	0.492	[-0.133, 0.064]
C'	-0.013	0.042	-0.022	0.738	[-0.096, 0.070]
C	-0.156	0.187	-0.834	0.405	[-0.524, 0.213]

5.8 Discussion

Our results show that body postures can cause changes in the perception of social dominance. People randomly assigned to sit in an expansive posture not only felt more powerful than people assigned to sit in a constricted posture, they also judged faces objectively differing in facial dominance to differ *less* in their level of dominance from each other.

These results add to the literature on changes brought about by posture manipulations and connect them to processes of social cognition of power and face evaluation. Recent studies suggest that body postures influence the sense of power, risk tolerance and physiological levels of some hormones (Carney et al., 2010). Moreover, these postures may have stronger influence on power-related behaviors than role assignment (Huang et al, 2010). However, it is time to explicate how posture brings about changes in power-related behaviors. Our results suggest that posture can feed back not only to changes in feelings of power, self-concept, and hormones, but also to how the environment is perceived and judged. Facial dominance is one of the two fundamental dimensions underlying face perception. There is enough consensus among judges to reliably model what a dominant face looks like. We observed that posture changed the use of this dimension. Compared to participants in constricted postures, participants in expanded postures polarized less between highly dominant faces and the rest. This difference was driven by their changed sense of power.

We showed participants faces that looked either very dominant, very submissive, or somewhere in between. These three levels were translated into two contrasts; and the results were clear-cut: posture affected primarily the differentiation between highly dominant faces and the rest, rather than between medium dominant faces and low dominant faces. Thus, the judgment of those higher in the hierarchy is what changes after adopting in a powerful vs. powerless posture. In contrast to the manipulation of facial dominance, we manipulated posture as constricted vs. expanded, and did not include a neutral control group. This is an obvious limitation of our study but was done primarily to concentrate statistical power in the two conditions. A neutral control group could either be realized by not giving instruction on posture (which would result in self-chosen postures and judgments being driven by interindividual differences), or as one with instructions to adopt a neutral posture. Such a condition could shed light on whether the expansion or the constriction was more responsible for our findings, and thus whether we found a de-polarization or a polarization of facial dominance.

Interestingly, we can speculate about what would happen if participants were judging faces not on dominance, but on other traits. For instance, in relation to the trustworthiness dimension of face evaluation (Oosterhof & Todorov, 2008), could we see a more extreme pattern of insensitivity from participants in a powerful posture? Given that trustworthiness judgments are related with cues of emotional value and powerful people tend to have less empathy (Schmid Mast, et al., 2009) and be worse in recognizing emotions (Kraus, et al., 2010), we can conjecture that powerful participants would also see less differences across the levels of trustworthiness compared to less powerful participants.

Moreover, in our study we only measured how body postures affect judgments of dominance. Other attention processes, such as gaze following, are essential tools in understanding others' intentions (e.g. Tomasello et al. 2005; Frith & Frith 2007). Furthermore, some studies reveal that humans and non-humans primates are more likely to shift their attention to more socially dominant conspecifics (Breton et al., 2014; Dalmaso et al., 2011; Jones et al., 2010; Shepherd, et al., 2006). The gaze cueing paradigm is the dominant approach used to study gaze following (e.g. Posner, 1980). In this paradigm, a face is presented looking either to the left or right and the participants are asked to answer as quickly as they can whether a posterior target appears on the right or left. As previously described, the gaze cueing effect (i.e. the tendency for participants to answer more rapidly to targets that were cued by gaze) is greater for dominant faces. Given this, we can hypothesize about the influence of body postures on attentional processes. Using the same stimuli and body postures of our study we may demonstrate a pattern that is similar to the one found in relation to dominance judgments. Therefore, participants in a powerful posture may show fewer differences on the gaze cueing effect between high dominant and low dominant faces than less powerful participants.

To summarize, we may find that the gaze cueing effect is larger for participants in a constrictive posture. The influence of body postures in interactions and judgments related to hierarchies has been shown in humans as in non-human primates (de Waal, 1982; Hall, et al., 2005). It is clear now that posture is tightly connected to hierarchy and power, and that posture and power influence each other in both directions. However, the influence of body postures in the perception of hierarchical relationships has been absent from the literature. To the best of our knowledge, the current study is the first to explore the influence of embodied power on the way people perceive differences in social dominance.

CHAPTER VI[22]

SELF-FACE AND REVERSE CORRELATION

Humans hold a mental representation of themselves; psychologists call this representation the self-concept (e.g. Baumeister, 1999). It is possibly one of the most complex concepts humans possess, and contains a multitude of aspects. Importantly, the self-concept is anchored to a representation of one's own body. Given its prominent role in our bodies, faces are a key feature for the notion of self (Tsakiris, 2008). The way we recognize and perceive our own faces is a fundamental aspect of self-identity (Sforza, Bufalari, Haggard, Aglioti, 2010).

Recent theories have assumed that bodily feedback may alter the way we conceive of our selves (Schubert & Koole, 2009). So far, this work has tested whether bodily feedback changes verbal judgments of the self. In the present work, we investigate whether such changes go beyond judgments of the self. Using an embodied manipulation (expansive versus constrictive posture) that changes feelings of power (Carney, Cuddy, & Yap, 2010; Huang, Galinsky, Gruenfeld, & Guillory, 2010; Yap et al., 2013) and a reverse correlation paradigm (Dotsch & Todorov, 2012; Dotsch, Wigboldus, Langner, & van Knippenberg, 2008), we intend to show how an embodied mechanism may change the internal mental self-portrait of the face, a concept called self-face (Sforza et al., 2010; Uddin et al., 2005).

6.1 Bodily Feedback

According to recent theorizing in cognitive science and social cognition (Barsalou, 2008; Niedenthal, 2007), cognition is embodied, that is, cognition is based on the way our body interacts with the environment. Evidence for such bodily influences comes from multiple areas of study: including language comprehension, evaluative judgments, and research on emotions among other

[22] This chapter is based on the paper Toscano, H., Schubert, T. W., & Dotsch, R., (*in prep.*). *Bodily postures can change self-face representation: A reverse correlation approach*. *Manuscript in preparation*.

areas. For instance, Glenberg and Kaschak (2002) showed that phrases are better comprehended when there is compatibility between the participants' actions and the actions depicted on text (for a review, see Fisher & Zwaan, 2008). Bodily movements such as arm flexion (i.e. approach behavior) and extension (i.e. avoidance behavior) facilitate positive and negative evaluations, respectively (Cacioppo, Priester, & Berntson, 1993). Additionally, a message may be considered as more persuasive when participants' head movements are vertical (i.e. nodding) that when they are horizontal (i.e. shaking) (Wells & Petty, 1980). In line with this reasoning, some studies demonstrated that facial feedback may influence judgments. Strack, Martin and Pepper (1988) showed that participants' judgments were more positive when they had to hold a pen between their teeth (facilitating a smiling expressions) than when the task was to hold a pen between their lips (inhibiting smiling).

Our body postures may also influence our self-related cognitive processing. Persons induced to adopt an upright posture on average feel more well-being and less stress than those in a slumped posture (Risking & Gotay, 1982). Feelings of power are higher in an expansive posture (i.e. spread of the legs and arms; upright posture) than in a constrictive posture (i.e. a curved upper-body; body closed inward; limbs held close to the body, Bohns & Wiltermuth, 2012; Carney et al., 2010; Huang et al., 2010; Yap et al., 2013). Participants in an expansive posture also took more risks, increased their approach behavior, and had a higher pain threshold and exhibited more stress tolerance. An expansive posture may even change hormone levels: testosterone was found to rise and cortisol decrease after one minute of expansive posture, compared to constricted posture (Carney et al., 2010). Another power-related behavior, the gesture of making a fist, was found to activate power concepts and change the way people judge their own internal image: men tended to see themselves as more assertive and powerful after making this gesture while under the guise of a cover story (Schubert, 2004; Schubert & Koole, 2009).

Most of the variables studied in these investigations were verbally expressed judgments or feelings. However, the very fact that bodily feedback can change such self-related cognitions implies that our bodily appearance is a part of our self-concept. And indeed, we all know what our body and our face look like and consider our appearance to be crucial, important, and in fact unique. We also tend to believe that we can judge well how others see us, and that this representation, this internal mental construct, should stay just as constant as our actual appearance stays constant. However, is that the case? Interestingly, work from cognitive psychology has shown that the body self-concept, or what we think we look like, is malleable. For instance, Tsakiris (2008) found that experiencing the illusion that another face seemingly merges with one's own as a result of multimodal synchrony leads to changes in what participants thought they looked like: features of a stranger's face they experienced synchrony with became part of the representation of their own face.

Given that bodily feedback changes our cognition and influences the way the self is judged, and that even the representation of our face is malleable, we hypothesize that body postures (expansive versus constrictive) related to dominant and submissive behaviors will have an effect on the mental representation of the self-face. More specifically, we predict that an expansive posture will lead participants to mentally create a self-face that is more dominant than the self-face represented by participants in a constricted posture. In sum, we want to show that our representation of our own face is, in part, the product of bodily feedback.

6.2 Overview of the Study

In order to create the picture of the internal mental construct of the participants have of their own faces we will use a reverse-correlation image classification paradigm (Dotsch & Todorov, 2012; Dotsch et al., 2008; Mangini & Biederman, 2004). Using this paradigm, it is possible to obtain a visual approximation of the visual mental representation of a certain category, trait or person. Mangini and Biederman (2004) demonstrated that this paradigm is useful to visualize representations of certain social categories. For instance, they asked participants to classify faces with random noise superimposed as male or female in many multiple trials. When the task was to select a female face the averaging of the faces chosen in every trial generated a classification image resembling a female face. The participants that had to select a male face generated an averaged classification image that looked like a male face. More recently, Dotsch et al. (2008) showed that this paradigm can be used to generate a visual depiction of the mental representation of stereotyped groups. They were able to demonstrate that more prejudiced participants generated an image that revealed that their mental representation of Moroccan immigrants (i.e., a stereotyped group) was more negative. These generated images were judged as more untrustworthy and criminal than the images generated by participants with less prejudice towards Moroccans. Classification images of in group members are usually more positive than those of out group members (Ratner et al., 2014). Even classification images of persons having certain traits (e.g., trustworthiness and dominance) can be obtained through this paradigm (Dotsch & Todorov, 2012).

These studies suggest that it is possible to obtain a visual depiction of a mental representation. With this in mind, in the current chapter we expect that participants' representation of their own face as diagnosed through a reverse-correlation procedure may depend on the specific body posture (expansive versus constrictive).

To test this hypothesis, we will manipulate body postures as being expansive versus constricted, following a procedure adapted from Tiedens and Fragale (2003). We intend to test whether a dominant (expansive) posture results in a visualisation of the subject's own face that is more dominant, than the one resulting from a submissive (constrictive) posture. More specifically, we will test whether the self-visualisation generated in the expansive posture looks more dominant than the self-visualisation generated in a constrictive posture.

Following the typical procedure of reverse correlation studies, the study has two phases. In the first, the participants judge stimulus faces superimposed with noise according to the target category, in this phase the judgment is whether the stimulus face resembles the subject's own face. In the second phase, the resulting classification images are judged by a new set of participants according to the dimension of dominance.

6.2.1 *Study 1a*

This study consisted of the image construction phase. We used a forced-choice reverse correlation method (e.g. Dotsch & Todorov, 2012; Dotsch et al., 2008; Mangini & Biederman, 2004). The goal of study 1a was to obtain visual depictions of participants' mental representations of their own faces while holding different postures.

6.3 Method

6.3.1 Participants. We had 81 participants (M_{age} = 21.74, *SD* = 3.10). The participants were from ISCTE-IUL, Portugal. Participants could win 120 € in vouchers in a lottery for participating in the study. All participants were male.

6.3.2 Materials. We used 600 hundred (300 pairs) grayscale pictures (400 x 400 pixels). All stimuli had the same base face[23] with random noise superimposed.

6.3.3 Procedure. Participants were run in single sessions. After they arrived at the lab and gave informed consent, their faces were photographed to ensure against randomization errors. After this they were told that the study was related with a marketing test of ergonomic chairs (Huang et al., 2010). Given this, they were told that they would have to sit in specific postures (see **Figure 6.1**). The way we manipulated postures was derived from Tiedens and Fragale (2003). In the expansive posture condition, participants were asked to be in an upright posture (i.e. raised head and shoulders), to put both arms on the armrests of the ergonomic chair, and to not put their legs together. In the constricted posture, participants were told round their back in to a slumped position and to close their legs. Participants were told that they would have to maintain the body postures until the end of the experiment.

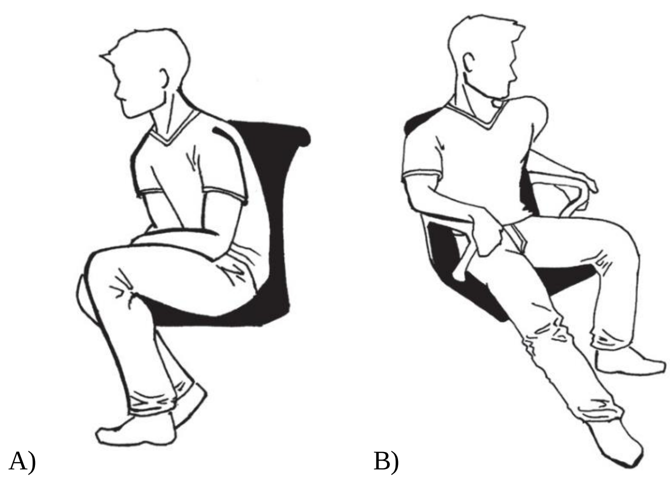


Figure 6.1*:* Bodily Postures: (A) Constrictive and (B) Expansive.

[23] The base face was a grayscale average male face of the Karolinska Directed Emotional Faces Database (Lundqvist & Litton, 1998).

After these instructions, they started the reverse correlation task. In 300 trials, participants were asked to think about their own faces and to choose from a pair of faces the one that most resembled them. Therefore, participants had to select the face that was more similar to the mental representation of their own face. Each trial presented two images on the screen side by side. Every image had always the same base face (**Figure 6.2A**). The two images presented by trial, one had a random-noise pattern added (**Figure 6.2B**) whereas another had a random-noise pattern subtracted (**Figure 6.2C**).

After the reverse correlation task, participants were asked to complete a questionnaire. To maintain the cover story of a marketing test, the first three questions were related with that: "How comfortable is this chair?", "What is the likelihood that you would buy this chair?" and "How much would you pay for this chair?". Importantly, for the manipulation check of the posture (Fischer et al., 2011), we asked participants to what extent they felt powerful, strong and superior on scales from 1 (not at all) to 7 (extremely).

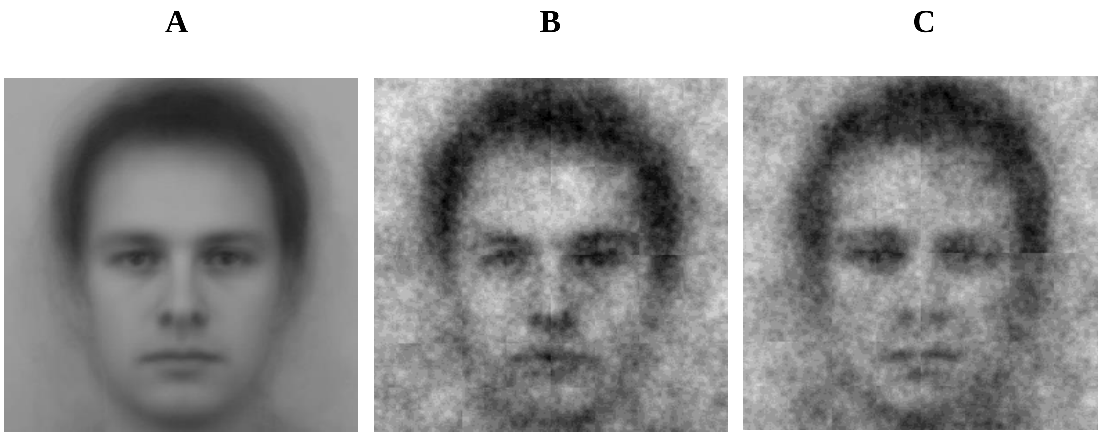


Figure 6.2*:* Example of stimuli used in the Study 1a. (A) Base face, (B) negative noise pattern superimposed on the base face, and (C) positive noise pattern superimposed on the base face.

6.4 Results

6.4.1 Feelings of Power. Powerful posture participants ($M = 4.00$, $SD = 0.88$) felt more powerful than submissive posture participants ($M = 3.34$, $SD = 0.96$), $F(1, 79) = 10.29$, $p = .002$, $n_p^2 = .115$.

6.4.2 Reverse Correlation Images. Each participant's choices were averaged in order to form an individual classification image of their own face. Once the classification image was computed based on the participants' choices a noise pattern was then added to distort the base image. Additionally, we averaged the individual classification images across participants for both the expansive posture condition (*n* = 40) and the constricted posture condition (*n* =41). Therefore, we were able to create an average image for each of the two conditions (expansive versus constricted posture. See **Figure 6.3A** and **6.3B**, respectively). On average, the images associated with the expansive posture responses are more "masculine" than the constrictive posture.

A **B**

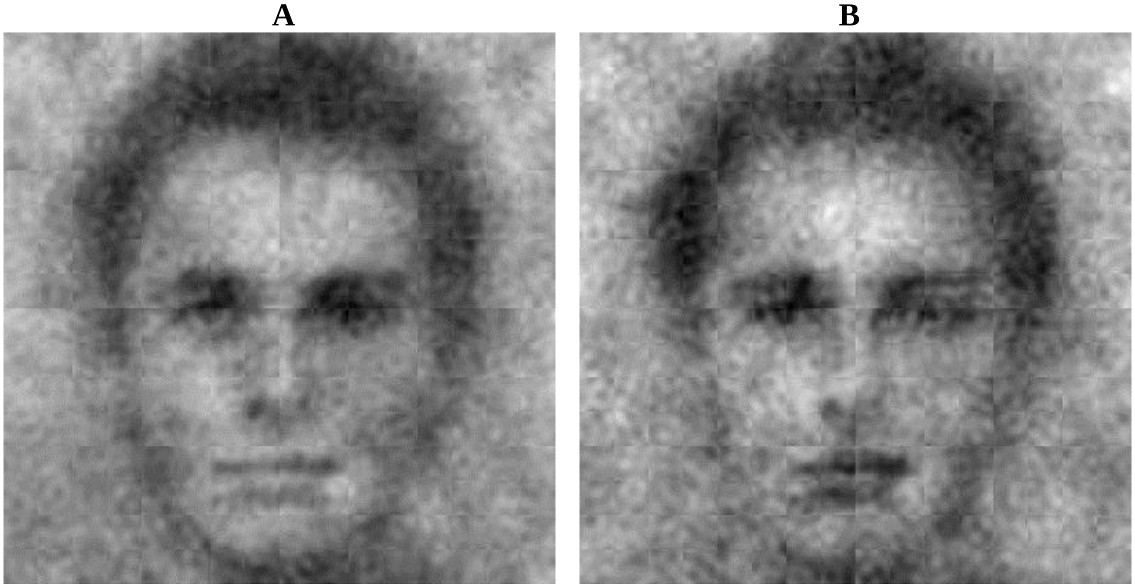


Figure 6.3*:* Average Classification image of each bodily group condition: A) Expansive versus B) Constrictive Posture.

6.5 Study 1b

This study consisted of the assessment of visual representations created in study 1a. In addition, in order to assure that participants' true appearance did not differ across conditions, I also asked for judgments on dominance of their faces.

The first step was to see whether the individual and group classification images in the expansive posture (i.e. dominant display) were judged as more dominant than the constrictive posture (i.e. submissive display) mental representations. More specifically, we wanted to empirically test that an expansive posture compared to a constrictive posture increased the dominance in the participant's mental model of their own face. Before the dominance questionnaire, we told participants that by dominance we meant "how much does this person want to influence other people and how much is she or he able to do so."[24]

For the average classification images we asked for additional judgments besides dominance in order to see whether this body posture only influenced the self-representation of the intended trait. Specifically, classification images were judged regarding physical strength, intelligence, trustworthiness, and emotional stability. For physical strength, we expected a similar pattern to dominance judgments given the high correlations between both traits (Toscano, Schubert, & Sell, 2014). However for the remaining three traits we did not expect significant differences given that these traits do not seem to be significantly correlated with dominance (see Oosterhof & Todorov, 2008). All judgment scales were from 1 (not at all a "trait" of the image) to 9 (a "trait" typified by the image). The order of the classification images was randomized.

6.5.1 Ratings of Participants' Face and *Individual Classification Image*. We paid $1.15 for each participant. For the *Average Image Classification Task*, we paid $0.60. All participants were recruited through Amazon Mturk (Buhrmester, Kwang, and Gosling, 2011).

6.5.2 Ratings of Participants' Real Faces (N = 39). Participants' actual, photographed faces in the expansive (M = 4.93, SD = 0.52) condition were not judged as more dominant than in the constrictive (M = 4.97, SD = 0.47) posture condition, $F(1, 38) = 0.82$, $p = .372$, $n_p^2 = .021$.

6.5.3 Individual Image Classification Task (N = 75). For this task, we followed the methodology of Imhoff, Woelki, Hanke, and Dotsch (2013). In order to keep the task reasonably short, we divided the 81 classification images randomly into three groups of 27 images each. Therefore, each participant only judged 27 images, and we recruited 25 participants for each image group. Participants judged the individual classification images of the powerful (M = 5.33, SD =

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[24] In this definition we include potential and motivational influence. Influence is a major characteristic of social dominance (e.g., Cheng, Tracy, Foulsham, Kingstone, and Henrich 2013).

0.85) posture condition as significantly more dominant than the ones from the submissive (*M* = 5.17, *SD* = 0.94) posture condition, $F(1, 74) = 5.15$, $p = .026$, $\eta_p^2 = .065$ (see Ratner et al., 2014, for the statistical analysis).

6.5.4 Average Image Classification Task. Regarding dominance judgments (*N* = 30), the average face generated in the expansive (*M* = 5.57, *SD* = 1.67) posture was judged as significantly more dominant than the face from the constrictive (*M* = 4.27, *SD* = 1.48) condition, $F(1, 29) = 17.04$, $p < .001$, $\eta_p^2 = .370$. As expected, the physical strength (*N* = 31) of the average face generated in the expansive (*M* = 5.35, *SD* = 1.45) posture was significantly higher than the face from the constrictive (*M* = 4.74, *SD* = 1.73) condition, $F(1, 30) = 6.80$, $p = .014$, $\eta_p^2 = .185$. The average face generated in the expansive posture (*M* = 5.28, *SD* = 1.10) was not judged as significantly more intelligent (*N* = 29) than the face generated in the constrictive posture (*M* = 4.97, *SD* = 1.15), $F(1,28) = 2.05$, $p = .164$, $\eta_p^2 = .068$. The same pattern occurred in relation to trustworthiness judgments (*N* = 33). The average face conceived in the expansive (*M* = 4.67, *SD* = 1.43) posture was not judged as significantly more trustworthy than the face derived from the constrictive (*M* = 4.27, *SD* = 1.46) condition, $F(1, 32) = 1.87$, $p = .182$, $\eta_p^2 = .055$. However, emotional stability judgments (*N* = 33) show that the average face from the expansive (*M* = 5.39, *SD* = 1.44) posture was judged as significantly more emotionally stable than the face from the constrictive (*M* = 4.33, *SD* = 1.02) condition, $F(1, 32) = 17.50$, $p < .001$, $\eta_p^2 = .354$.

6.6 General Discussion

Previous theorizing and evidence has shown that feedback from performed actions influences not only feelings and physiology, but also judgments of the self. What this shows is that the self-concept is embodied; and includes sensory-motor representations. Previous research has manipulated body variables and assessed verbal ratings of the self. Here, we go a step further and show that bodily feedback from one’s posture impacts the self-concept such that it actually changes one’s idea about the appearance of one’s face. Participants who sat in an expansive posture not only felt more powerful than participants who sat in a constricted posture, but they also held mental representations of their own face that, when visualised, looked more dominant. The visualisation of that was achieved using a reverse correlation paradigm.

In more detail, the reverse correlation forced-choice paradigm applied in the current study (Dotsch et al., 2008) showed that the visual approximation of both individual and the average mental representations of their own face were judged as more dominant by new participants when generated in an expansive posture compared to a constrictive posture. However, the differences on dominance judgments between expansive and constrictive posture conditions were stronger for the average classification images than for the individual classification images. This might be related to the fact that the individual classification images have more noise than the average classification images. The average classification images do not have their noise eliminated, but it is considerably reduced compared to the individual classification images (Dotsch et al., 2008; Ratner et al., 2014).

In relation to other trait judgments, our data shows that the self-portraits generated in an expansive posture were judged as physically stronger and more emotionally stable than the facial images derived from the constrictive posture condition. The pattern for the physical strength trait was expected given the positive interrelations between dominance and physical strength judgments (Toscano et al., 2014). The results related to emotional stability judgments seem to be unexpected given the fact that this trait is not usually correlated with dominance (see Oosterhof & Todorov, 2008). We can speculate that this finding is linked to the fact that Neuroticism (the opposite end of Emotional stability) is stereotypically associated with women (Bergh, Akrami, & Ekehammar, 2012; Ekehammar, Akrami, & Araya, 2000). Women tend to be judged as less emotionally stable than men. Given that the self-portraits generated in the expansive posture look more masculine and the self-portraits generated in the constrictive posture more feminine, participants were probably applying gender stereotypes while judging emotional stability. The other traits trustworthiness and intelligence did not show differences, which was expected because they are not, generally, associated with dominance (Oosterhof & Todorov, 2008).

Our findings add evidence to the literature on embodied cognition in a fundamental way: typical research in embodied cognition either manipulate a sensory-motor state (e.g., a posture), and study effects on judgments and experiences that are typically tapped through verbal measures, *or* they reverse the causal direction and investigate how cognition reveals itself in spontaneous behavior. In the current experiment, we induced a posture (motor behavior, proprioceptive feedback) with the goal to manipulate the embodied self-concept, and then tapped that embodied self-concept in a different modality (visual). We were not the first to show effects of one embodiment condition on another (see Tsakiris, 2008), but we believe that this is an interesting extension of earlier work because it might reveal the structure and dependencies of the modal, embodied self-concept.

The mental representation of our self seems to be in part dependent of our body states. This suggests that the representation of the self is grounded, to some extent, in our bodies. The self seems to be influenced by physical circumstances. Therefore, the consequences of embodiment may go further than cognitive, emotional, and evaluative processes, or hormonal levels (Barsalou, 2008; Carney et al, 2010; Niedenthal, 2007). It is possible that embodied processes go beyond cognition about the environment and others, and includes the self.

Nonetheless, this study has some limitations: first, the visualization of the self-face was dependent on both the base face and noise used to make the stimuli. Therefore, the classification generated images were not an exact image of our participants' self-face. If future studies were to use the participant's own face as a base image and generate stimuli on the fly, the resulting self-portraits may have more clarity. Moreover, we only manipulated expanded versus constricted postures, and did not include a neutral group. A neutral group could have shown more clearly whether the differences between self-portraits were driven more by the expansion or the constriction of postures. Additionally, because our base face looked masculine, we have used only male participants. Therefore, it is unclear whether female participants would generate a self-image consistent with our results.

6.7 Conclusion

This chapter intends to show how an expansive versus a constrictive body posture affects the mental representation of our own face. Using a reverse correlation paradigm, we were able to reveal that posture plays an important role in the visual estimate of the self-face representation. Therefore, these findings suggest that our bodily actions influence the mental representation of the self.

CHAPTER VII[25]

THE EFFECT OF MULTISENSORY SYNCHRONY ON JUDGED AND REMEMBERED TRUSTWORTHINESS OF FACES

One's concept of the own body shows an amazing degree of plasticity. Humans hold a representation of the own body, a body image, which is updated continuously, This process is sensitive to multiple sensorial channels and kinds of stimulations (Maravita, Spence, & Driver, 2003). One key element of stimulations that update the body image is synchrony of various channels. For instance, in a study by Blanke and Metzinger (2009), the participants' own conception of their bodies showed a great flexibility, and extended to the inclusion of extracorporeal body-parts in their conceptualization when seen and felt stimulation were synchronous.

One of main examples of this flexibility of the body representation can be seen in the rubber hand illusion (RHI). In this illusion the body image changes when a prosthetic hand is being brushed synchronously to felt brushing on the actual hand. This causes the prosthetic hand to be perceived as actually being one's own hand (compared to asynchronous stroking, Botvinick & Cohen, 1998; Tsakiris & Haggard, 2005). Recent studies have shown that this illusion also occurs with one of the most distinguished attributes of a person's identity, that is, the face. This is what is called "enfacement effect" (Paladino, Mazzurega, Pavani, & Schubert, 2010; Sforza, Bufalari, Haggard, & Aglioti, 2010; Tajadura-Jiménez, Grehl, & Tsakiris, 2012a; Tsakiris, 2008).

Previous work has shown that such changes during bodily illusions go along with changes to how one perceives and relates to the individuals whose faces or bodies are involved. Synchronous rhythmic stimulation can cause people not only to incorporate others' faces at a body representation level, but also to merge and identify with others who experience the same stimulation synchronously at a social level (Paladino et al., 2010). This provides an interesting bridge to explain why synchrony is such a potent element in the creation and maintenance of social

[25] This chapter is based on the submitted paper Toscano, H, & Schubert, T. W. (2014). *The effect of multisensory synchrony on judged and remembered trustworthiness of faces*. Manuscript submitted to publication.

relations (Fiske, 2004). In the current research, we extend previous work on this, and investigate the role that synchronous rhythmic stimulation plays for one of the two key dimensions of face perception, facial trustworthiness.

7.1 Enfacement Illusion and its Role in Social Perception

The rubber hand illusion describes a feeling of incorporation of body parts that are not actually own body parts. It can be extended to other parts of the body, particularly the face. In a typical paradigm, this "enfacement effect" is created through the touch on the cheek of the participants while they see a face of other person being touched in a synchronous way. This type of procedure recreates an experience that resembles the one when we look at ourselves in a mirror, although in this case our reflection is replaced by the face of other person. The illusion was firstly reported by Tsakiris (2008). In his study, when the participants were touched synchronously with touches applied to a stranger's face in a video, they saw more similarities between them and a stranger's face than after being touched asynchronously. This effect was found when assessing what people judged what their own face actually looked like (using morphs composed of the own and the other's face): The stranger's face influence the visual representation of the own face after synchronous stimulation.

Paladino et al. (2010) showed that a synchronous multisensory stimulation has effects beyond the body features, and plays a role in social perception. Blurring of bodily boundaries between self and other can lead us not only to see physical resemblance, but also to feel psychological closeness closer and judge similarity (see also Mazzurega, Pavani, Paladino, & Schubert, 2011). Finally, this study included a conformation task as a dependent variable. This task showed that participants aligned estimates more with anchors given by synchronously touched strangers than asynchronously touched ones (see also Mazzurega et al., 2011).

In sum, the "enfacement illusion" leads to a blurring of self-other boundaries, but also enhances the social closeness towards the other. We feel that a face has more resemblance with our own face when we are touched in temporal and spatial synchrony as the face of a stranger, and this illusion increases the social bonding with the other. Our goal here is to investigate how this illusion translates into processing of face evaluation.

7.2 Face Evaluation and the possible Role of the Enfacement Effect

People rapidly and automatically infer traits from many social dimensions (e.g. Willis & Todorov, 2006). Even when we do not deliberately evaluate faces, studies show that we tend to automatically categorize them (Engell, Haxby, & Todorov, 2007; Todorov & Engell, 2008). Evaluation of faces is a great source of valid information about a person, and inferences of traits based solely on faces can predict important social outcomes, from elections (e.g. Hall, Goren, Chaiken, & Todorov, 2009) to judicial decisions (Blair, Judd, & Chapleau, 2004; Zebrowitz & McDonald, 1991).

Oosterhof and Todorov (2008) unpacked the underlying dimensions of those trait judgments in a bottom-up, data driven series of studies. According to their model, faces are evaluated mainly on two dimensions: valence and dominance. Valence seems to be the more important dimension. In their studies, all positive judgments (e.g., trustworthy, emotionally stable) had positive loadings and all negative judgments (e.g., mean, weird) had negative loadings on this dimension. They also demonstrated that the valence dimension could be approximated by judgments of trustworthiness. Thus, the trustworthiness judgments can be seen as a proxy of general valence.

Nevertheless, the question is how trustworthiness or positivity is determined. In the literature, little is known about the mechanisms underlying the development and the generalization of face preferences. One known mechanism is associative learning: Jones et al. (2007) have shown that composites of faces associated with neutral sounds were preferred to composites of faces associated with an aversive sound. One of the sources of such learned affective connotations are regular interactions: Zebrowitz and Collins (1997) claimed that individuals will consider faces that resemble significant others, friends, and themselves as more trustworthy. According to these authors, the idiosyncratic face preferences of each of us are thus partially the result of the different persons that we are familiar with. They called this the familiar face overgeneralization hypothesis. So, individuals will consider faces that resemble significant others, friends, and themselves as more trustworthy.

Kraus and Chen (2010) demonstrated that the process of transference, that is, the process whereby a person's mental representation of someone close is transferred to a new person, can be obtained when this new person shows facial resemblance with someone's significant other. According to DeBruine (2002), trust game partners that resembled more the participants' own face were more trusted. Recently, Farmer, McKay and Tsakiris (2013) showed the reverse. Thus, when trust was reciprocal during the trust game the participants judged the game partners as more similar to them.

Verosky and Todorov (2010) argued that learning and similarity can form a causal chain. In their research, they showed that a general mechanism of learning based on facial similarity can account for different facial preferences. For example, faces that were similar to faces previously associated with positive behaviors were considered more trustworthy than faces similar to those previously associated with negative behaviors. More recently (Verosky & Todorov, 2013) showed that this process of generalization may occur in an automatic way and even when the participants are instructed not to use cues related to similarity. Thus, social interactions can influence the evaluation of novel faces. The preference for faces that resemble one's own face fits neatly into this model, as most people may have a positive association with themselves and indeed their face.

In sum, these findings show that face preferences may be the product of learned associations between experiences with some persons (including the self) and facial cues, and the generalization of those associations to new faces. However, no study has yet investigated the role of the embodied processes, particularly the "enfacement illusion", in the evaluation of faces. The current goal is thus to test if the facial evaluation will be affected by a bodily illusion. To test this hypothesis we designed two studies to test the impact of a synchronous multisensory stimulation on face evaluation.

7.3 Study 1

The main goal in this study is to test whether a synchronous experience with a face will influence the judgment of that face and similar faces that resemble the "synchronous face". The hypothesis of the study is that synchrony will generalize preferences for similar novel faces. We predict that if participants are stroked in face while seeing the face of another person being stroked in a synchronous way, they will judged that synchronous face as more trustworthy, but also faces that resemble it (compared to asynchronous stroking).

In the experiment we used the face illusion paradigm (Tsarikis, 2008). Tsakiris (2008), using morphs that were composites of the participant's face and a stranger's face, showed than when the participants were touched synchronously with touches applied to the composite face, they perceived more similarities between them and the composite face than after being touched asynchronously. Our procedure was similar: Another's person face was presented on a screen and was stroked in synchrony or asynchrony with stroking applied to the participant's own face. After experiencing this synchronous or asynchronous experience, participants had to evaluate how trustworthy the faces appeared to be. The presented faces were both the faces seen in the videos, and morphs of the seen faces with new faces. These morphs were in the categorical boundary of the novel faces, because they had at least 65% of one of the novel faces (Jacques & Rossion, 2006; Levin & Beale, 2000). Thus, the resemblance of the faces seen being stroked with the morphed faces was obscured. The novel faces were morphed with 20% or 35% of the stroked faces (see Verosky & Todorov, 2010). We expected the faces morphed with the "synchrony faces", that is, faces with which the participant experienced synchrony, to be seen as more trustworthy than faces morphed with "asynchronous faces" (i.e. faces seen after an experience of asynchrony) . Furthermore, the effect of synchrony experience should be higher for the 35% than the 20% morphs.[26]

7.4 Method

7.4.1 Participants

We collected data from 72 participants in Lisbon, Portugal. All were White and native speakers of Portuguese; 57 of them were female, mean age was 21.10, SD = 2.35. The participants

[26] The transformation from natural to computer-generated faces could have led to some loss in the process of morphing, that is, the computer-generated faces were not completely 100% equal to the faces seen on the screen during the stroking manipulation. Therefore the levels of morphing are probably slightly less than 100%, 35% and 20%. This implies that the 35% morphs have more than 65% of a novel face, which makes them even more novel faces.

were from various faculties of the Lisbon University and the Lisbon University Institute. All received a 5 € voucher for their participation.

7.4.2 Materials, Procedure, and Design

We created 4 videos (Female 1, Female 2, Male 1, Male 2; Age range: 21-25 years). All models were White. In addition, we took photos of the models' faces. After that we created 3D models of these target faces with FACEGEN software (Facegen Main Software Development, 2006). Thus, each target face that was seen in the video was judged as a computer-generated face, rendered from the 3D model by using the PhotoFit application of the FACEGEN software. This enables to create a 2D photo of the face while maintaining the structure of the target face.[27] Then we created 80 morphs to each one of the four target faces with the software Morpheus Photo Mixer (http://www.morpheussoftware.net). The starting faces of these morphs were taken from Todorov Database (http://tlab.princeton.edu/). We also used 80 filler faces (20 for each one of the models, **see Figure 7.1**).

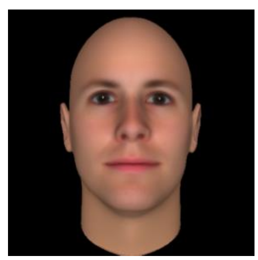
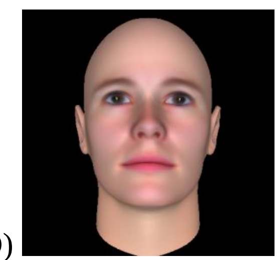
A)  B)  C)  D) 

Figure 7.1: Examples of the faces judged in Study 1: A) Computerized version of the target face; B) 35% morph of the target face; C) 20% morph of the target face; D) filler face.

During the experiment, a video of a face being stroked was shown on a screen in front of the participant. The face was stroked on the cheek with a brush. While the participant was seeing the video, her or his cheek was stroked in synchrony or asynchrony with the video. The videos were five minutes long: one minute showing the face without being stroked, three minutes of

[27] One of the limitations of this method might be related with the fact that while the target faces during the trustworthiness judgments were computer-generated faces and bald, they were seen in the videos with hair and as natural faces. This might cause some issues, but at the same time enables me to take into account only the structure of the face and not other features such as the hair.

stroking, and one more minute without stroking. Each participant saw two movies of two different target persons, and synchrony was manipulated between these target persons, and thus within participant. Both targets had the same gender as the participant. For instance, when a female participant first experienced synchrony with the female 1 video, in the second movie she was stroked in asynchrony with the female 2. Order of synchrony vs. asynchrony was counterbalanced. After each stroking of the face, participants evaluated faces.

Face evaluation. In the evaluation phase of the experiment, participants were told that we were interested in first impressions of faces, and that there were no right or wrong answers. We asked the participants to judge faces on the dimension of trustworthiness. Each of the four video faces was morphed with 40 novel computerized faces at two different levels of morphing (20% and 35%). Half of the novel faces were shown at one morphing level and half at the other, and these were counterbalanced across participants. The target faces seen on the screen were also evaluated (as a computer-generated face).

Each trial started with a 1000-millisecond fixation cross. The face remained on the screen until the participant responded using the number keys from 1 (not at all trustworthy) to 9 (extremely trustworthy). Each participant rated all faces twice. These were randomly presented.

Enfacement Questionnaire. Besides the ratings of faces, we used a face illusion questionnaire to see which of the variables of the illusion could mediate the ratings of faces. After each video, participants rated their sense of ownership (e.g., “It felt as if my face was turning into the face in the video,” 4 items), agency (e.g., “Sometimes I had the impression that if I had moved my eyes, the eyes of the person in the video would have moved too,” 3 items), and location (e.g., “It seemed as if the touch I felt was caused by the paintbrush touching the face in the movie,” 3 items; Longo, Schüür, Kammers, Tsakiris, & Haggard, 2008).

Physical Resemblance. Participants judged how much the target resembled their own facial features on a list of features. We created an index of general resemblance. Moreover, using the responses of the participants regarding the regions of the mouth, eyes, and nose, an index of resemblance of core features was established (Paladino et al., 2010). The forehead, cheeks, chin, and face shape ratings led to formation of an index of resemblance of peripheral facial features. All responses were given on a scale from 1 (not at all similar) to 7 (completely similar).

Liking. Four items assessed how much the participant liked the face of the actor (e.g., "How much did you like the face seen on the video?", "How nice do you think is the person seen on the video?").

Inclusion of the other in the Self. Participants judged their relationship with the actor seen on the video through a modified version of the IOS scale (Schubert & Otten, 2002). In sum, the design of the study was 2 (Type of Stroking: Synchronous vs. Asynchronous, within participants) X 3 (Morphing: 100% vs 35% vs. 20% of the faces seen on the screen, within participants) x 2 (Order of Stroking: First Synchrony vs First Asynchrony, between).

7.5 Results

We averaged the trustworthiness ratings according to conditions, and analyzed them in a 2 (type of stroking) x 3 (morphing) x 2 (order) GLM. The target faces (100% of morphing, i.e., the original faces in their computerized version) were evaluated as more trustworthy after synchrony (M = 3.10, SD = 1.71) than after asynchrony (M = 2.93, SD = 1.56), but this difference was not significant, F (1, 70) = 0.78, p = .38, η_p^2= .011). When we look at the two different levels of morphing, the results were similar. The 35% morphs were rated only marginally more trustworthy after synchrony, (M = 4.74, SD = 1.15) than 35% morphs after asynchrony, (M = 4.58, SD = 1.24), F (1, 70) = 3.63, p = .061, η_p^2=.049. After experiencing synchrony, the 20 % morphs were seen as equal trustworthy (M = 4.57, SD = 1.08) as after experiencing asynchrony (M = 4.54, SD = 1.06), F (1, 70) = 0.18, p = 0.671, η_p^2 = .003. Besides that, we had a main effect of morphing, F (2, 69) = 88.43, p < .001, η_p^2 = .558. Thus, the 35% morphs (M = 4.66, SD = 1.14) were considered as more trustworthy than the 20% morphs (M = 4.55, SD = 1.02), p < 0.003, and the target faces (M = 3.01, SD = 1.42), p < .001. The 20% morphs were also judged as more trustworthy than the target faces, p < .001. We did not find a main effect of order of stroking, F (1, 70) = 0.061, p < .806, η_p^2 = .001.

Although there were no main effects of synchrony, we did find an interaction of order of stroking and type of stroking, F (1, 70) = 6.70, p = .012, η_p^2 = .087. When the synchronous condition came before the asynchronous one, participants rated the faces as more trustworthy after synchrony (M = 4.28, SD = 1.14) than after asynchrony (M = 3.93, SD = 1.08), F (1, 70) = 7.76, p = .007, η_p^2 = .100). In comparison, when asynchronous stroking came before synchronous stimulation, there was no difference between the evaluation trustworthiness of faces in synchrony (*M* = 3.99, *SD* = 0.96) and asynchrony (*M* = 4.10, *SD* = 1.10), F (1, 70) = 0.76, p = .385, η_p^2 = .011.

There was no significant interaction between order of stroking, type of stroking and morphing, F (2, 140) = 2.25, p = .109, η_p^2 = .031. We nevertheless checked effects at the three levels of morphing. When synchrony was the first condition, the 35% morphed faces were evaluated as significantly more trustworthy (*M* = 4.81, *SD* = 1.10) than the 35% morphed faces after asynchrony (*M* = 4.49, *SD* = 1.19), F (1, 70) = 7.87, p = .007, η_p^2 =.101. Similarly, the (100%) target faces were evaluated as more trustworthy when the synchronous stroking (*M* = 3.44, *SD* = 2.06) came before the asynchronous one (*M* = 2.86, *SD* = 1.69), F (1, 70) = 4.78, p = .032, η_p^2 = .064. In the 20 % morphs there were no significant differences between the synchronous (*M* = 4.58, *SD* = 1.08) and asynchronous stroking (*M* = 4.45, *SD* = 1.01), F (1, 70) = 1.34, p = .252, η_p^2 = .019 even when synchrony came first.

When asynchronous stroking took place before the synchronous manipulation, there were no significant differences in target faces between the synchronous (*M* = 2.75, *SD* = 1.20) and asynchronous (*M* = 3.00, *SD* = 1.43) stroking of the target faces, $F < 1$. The same also occurred for the 35% (Synchrony: *M* = 4.66, *SD* = 1.21; Asynchrony: *M* = 4.67, *SD* = 1.30), $F < 1$, and 20% morphs (Synchrony: *M* = 4.56, *SD* = 1.09; Asynchrony: *M* = 4.62, *SD* = 1.13), $F < 1$ (**Figure 7.2 summarizes the results**).

In the face illusion questionnaire, the order of the conditions also influenced the results. Thus, the variables related to the illusion (i.e., ownership, location, agency and affect), were significantly different when the synchronous manipulation condition came first; ownership (MSynchrony = 1.11, MAsynchrony = -0.63, t (35)= 5.59 , p < .001), location (MSynchrony = 0.40, MAsynchrony = -1.31, t (35) = 7.67 , p < .001), agency (MSynchrony = -0.38, MAsynchrony = -1.41, t (35) = 3.82 , p = .001) and affect (MSynchrony = 1.26, MAsynchrony = 0.56, t (35) = 3.52 , p = .001) showed significant differences.

In contrast, when asynchrony came first, a significant differences was only found for location (MSynchrony = 0.47, MAsynchrony = 0.01, t (35) = 2.08, p = .045), and there was a marginal difference in ownership (MSynchrony = -0.68, MAsynchrony = -0.11, t (35) = 1.88, p = .068). Note that this effect on ownership shows a different pattern of what was expected, because it was stronger after the asynchronous stimulation. Agency (MSynchrony = -0.58, MAsynchrony = -0.57, t (35) = 0.063, p = .95) and affect (MSynchrony = 1.12, MAsynchrony = 1.23, t(35) = 0.69 , p = .495) did not show any significant differences.

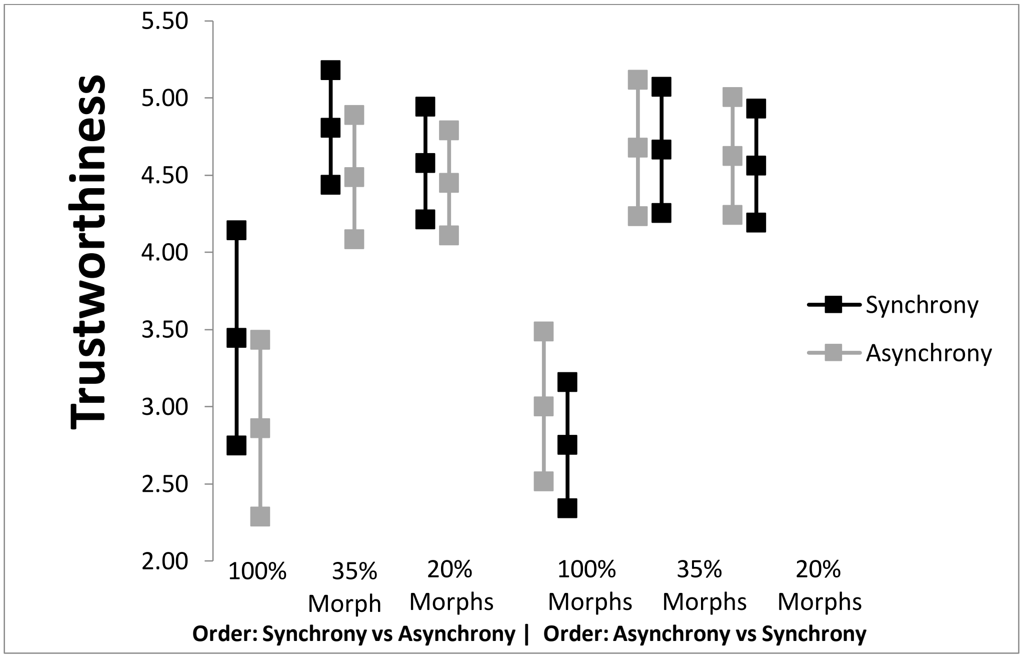


***Figure 7.2*: Means and 95% Confidence Intervals of trustworthiness judgments according to type of stroking (synchrony vs asynchrony), order (Synchrony vs Asynchrony/ Asynchrony vs Synchrony) and Morphing (100% vs 35% vs 20%).

The variables of physical resemblance did not show any significant differences. Thus, the participants did not see themselves as more similar to the synchronous (M = 3.22, SD = 1.21) than the asynchronous target (M = 3.19, SD = 1.28), F (1, 71) = .083, p = .775, ηp2 = 0.001. In addition, the resemblance of the core features did not show any differences between the synchronous (M = 2.93, SD = 1.34) and asynchronous (M = 2.89, SD = 1.27) stimulation, F (1, 71) = 0.091, p = .764, ηp2 = .001. The pattern was the same for the synchronous (M = 3.12, SD = 1.26) and asynchronous (M = 3.19, SD = 1.41) face for the resemblance of the peripheral facial features, F (1, 71) = 0.267, p = .607, ηp2 = .004. When the order of the conditions was taken into account, only the resemblance of the peripheral features showed a significant difference between synchronous and the asynchronous, but when the asynchrony come first (MSynchrony = 3.18, MAsynchrony = 3.52, *t* (35) = 2.20, p = .035). However, the effect was not as predicted here, because participants considered the target faces as having more similar peripheral features after the asynchronous stimulation. All the other variables related with physical resemblance did not show any interaction with the order of the stroking (ps > .05). Participants also did not like the face more after the synchronous stimulation (M = 3.75, SD = 1.10) than after the asynchronous one (M = 3.86, SD = 1.05), *F* (1, 71) = 0.881, p = .351, ηp2 = .012.

For the felt overlap, we found that participants did not feel more overlap on the IOS to the synchronously stimulated face (M = 2.44, SD = 1.14) than to the asynchronously stimulated face (M = 2.43, SD = 1.18), F < 1. There was not any interaction with order of the stroking, p >.05.

7.6 Discussion

In Study 1, we tested for the first time whether experiencing stimulation of the own face in synchrony with perceived stimulation of a stranger's face influences how trustworthy that stranger is judged. We manipulated synchrony within participants, and counterbalanced order of synchronous vs. asynchronous stroking, as it was done in previous studies. We predicted that synchronous stimulation would lead to both the enfacement illusion and enhanced judgments of trustworthiness. We found this difference, but only if synchronous stimulation came before asynchronous stimulation. Synchrony only increased trustworthiness for the target faces themselves and morphs where those faces contributed 35%. No difference was found if the stimulated targets contributed only 20% to the morphs. When the synchronous stimulation followed the asynchronous stimulation, we found neither a reliable illusion nor changes in trustworthiness. Similarly, the enfacement illusion occurred only when synchronous stimulation came first (comparing synchronous to asynchronous stimulation).

The effect of order was unexpected. Even though the within manipulation of synchronous is standard practice, previous studies rarely tested for order effects, possibly due to small cell sizes (e.g., Paladino et al., 2010). What happened here? On the one hand, it could be that due to unchecked influences, some participants in the asynchrony first condition did not experience illusion and thus social outcomes in the same way (i.e., the interaction is due to error variance). However, it is noteworthy that Tajadura-Jiménez et al. (2012b) also found an interaction with order, where they reported that the difference between the synchronous and asynchronous stimulation were much smaller when asynchrony was first than when the synchronous stimulation was taken in the first place (the same pattern that we found as well), but they discussed this not further. This suggests that this difference might be meaningful. In ongoing work, we Toscano, Schubert and Waldzus (2014) found similar order effects while replicating the effects of synchrony on perceived entitativity (see Lakens, 2010). The effects of synchrony on the perceived entitativity were larger when the synchronous condition came before the asynchronous than the other way around. In sum, it seems that the interaction with order we obtained here is meaningful. Importantly, the effect was not opposed but simply zero when asynchrony came first. Such interactions might not have been noted in earlier work because cell sizes were too small, and the effect larger than the one we tested here, so that the effect in the synchrony first condition still caused a significant main effect.

7.7 Study 2

Study 2 aimed to conceptually replicate Study 1. We used a very similar design, but a different dependent variable from the same literature. This variable was more indirect. Specifically, instead of participants rating trustworthiness of a face on a scale, we presented them the face they saw in the video together with morphs of that face. These morphs contained either various degrees of a very trustworthy face, or various degrees of an untrustworthy face. Participants had to select which of the presented faces they saw during the video. Thus, we tested whether they distorted their memory for the synchronously or asynchronously stimulated face either towards trustworthy or untrustworthy appearance. To follow up on the interaction with order in Study 1, we again counterbalanced order.

In addition, we investigated situational influences on the inference process from illusion onto trustworthiness. We reasoned that synchronous stimulation and incorporation of another person should be a particularly valid cue in a context of communal sharing relations. However, when the context is one of authority relations, incorporation should not be a valid cue, and thus not impact trustworthiness. Similar predictions were confirmed in recent work by Giessner, Schubert, and Ryan (2012). These authors found that size cues (who is taller) only affect judgments of authority when the context of authority relations was primed beforehand. When a neutral context was primed, tallness had no effect. We used the priming manipulation of these authors, comparing friendship priming to authority priming and a no priming control condition.

7.8 Method

7.8.1 Participants

We had 116 participants. They were all White women, mean age was 22.33, *SD* = 2.16. The participants were recruited from various faculties of the Lisbon University and the Lisbon University Institute. Every participant received a 5 € voucher or a university credit for their participation.

7.8.2 Materials, Procedure, and Design

Overall, the procedure was the same as in Study 1. We used three videos (Female 1, Female 2, Female 3).[28] As in Study 1, we took photos of the models' faces and stroked the participants' cheek while they were seeing the videos (same duration as in Study 1). Each participant saw two movies, and their faces were stroked in a synchronous or an asynchronous manner. Again, order of synchrony vs. asynchrony was counterbalanced.

Before seeing the videos, some participants were primed. They either received no prime, or were primed with authority, or were primed with friendship. In these primings, we asked the participants to think about friendship or authority. More specifically, we asked them to think and define a person in authority in general (vs. a friend) and to write down the five most important aspects that can describe an authority (vs. a friend).

As in Study 1, we used the questionnaires of the enfacement illusion, physical resemblance, liking and inclusion of the other in the self.

[28] We created three videos of three different persons because we thought that one of the target faces could be recognized by the participants because she was from the same institution. However, we did not find any effect of the target face ($p > .05$).

Face Selection. After each video, the participants were presented with a random lineup that contained 11 faces (see Epley and Whitchurch, 2008) and were asked to identify the face they saw previously on the screen. One of the faces was the actual face seen during stroking, 5 were morphed with a trustworthy face (up to 50%), and 5 with an untrustworthy face (up to 50%) (**see Figure 7.3**).[29]

The design was thus a 2 (Type of Stroking: Synchronous vs. Asynchronous) X 2 (Order: First Synchrony vs First Asynchrony) within participants X 3 (Prime: Neutral vs Authority vs. Friendship) between participants.

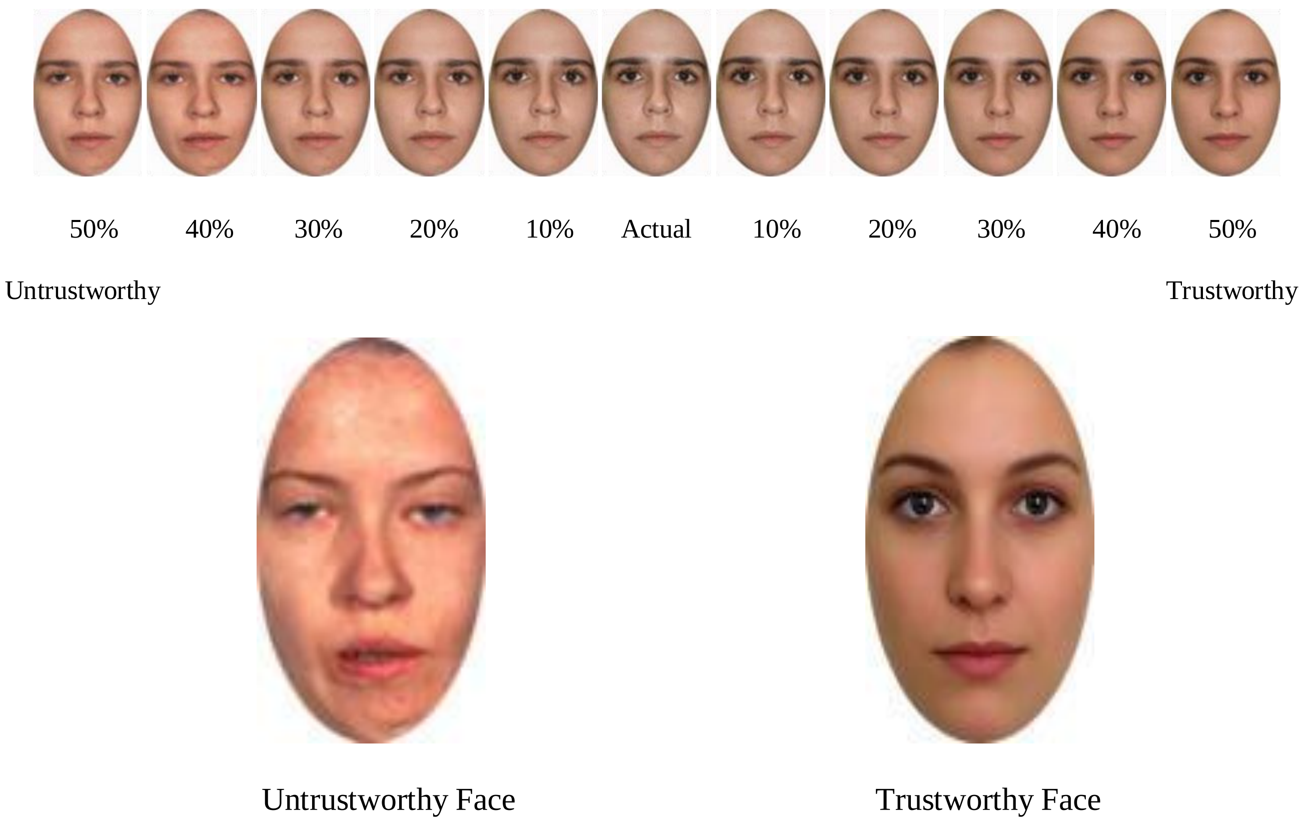


Figure 7.3: Example of the Faces and Morphs used in Study 7.2

[29] These two faces were pretested for trustworthiness. The trustworthy face was judged as significantly more trustworthy, $p < .05$.

7.9 Results

The main dependent variable was whether participants chose a more trustworthy or a more untrustworthy morph of the face they saw during stimulation as the face they remembered. This variable was submitted to a 2 (Stroking type) x 2 (Order) x 3 (Prime) GLM.

The participants identified after a synchronous stimulation a more trustworthy face (*M* = 0.87, *SD* = 1.77) that after an asynchronous stimulation (*M* = 0.36, *SD* = 2.02), *F* (1, 110) = 3.96, *p* = .049, η_p^2 = .035. We did not find an order effect; faces were equally trustworthy whether synchronous stimulation (*M* = 0.64, *SD* = 1.34) or asynchronous stimulation (*M* = 0.57, *SD* = 1.34) came first, *F* (1, 110) = 0.091, *p* = .764, η_p^2 = .001.

We did find a main effect of priming, *F* (2, 110) = 3.810, *p* = .025, η_p^2 = .065. There were no significant differences between the authority (M = 0.77, SD = 1.34) and friendship primes (*M* = 0.93, *SD* = 1.34), but judgments after neutral primes were lower (*M* = 0.119, *SD* = 1.34) than in the friendship, *p* = .10 and the authority condition, *p* = .038.

With respect to the interactions, we did not find an interaction between the type of stroking and prime, *F* (2, 110) = 0.198, *p* = .821, η_p^2 = .004, nor an interaction between stroking type and order, *F* (1, 110) = 0.005, *p* = .943, $\eta_p^2 < .001$. However, we found a three-way interaction between type of stroking, order, and prime, *F* (2, 110) = 3.75, *p* = .027, η_p^2 = .064. When the prime was neutral and the first stroking was synchronous, participants selected a more trustworthy face after synchrony (*M* = 0.74, *SD* = 1.05) than after asynchrony (*M* = -0.79, *SD* = 1.99), *p* = .012. However, when the asynchronous stimulation was first, there was no significant difference between synchronous (*M* = 0.06, *SD* = 1.48) and asynchronous stimulations (*M* = 0.47, *SD* = 2.29), *p* = .52. This pattern thus resembles the one found in Study 1.

In the two conditions with primings, this looked different. After the authority priming, there was a marginal effect when the first stroking was asynchronous: Participants then selected a more trustworthy face after a synchronous (*M* = 1.11, *SD* = 1.97) than after an asynchronous stroking (*M* = 0.11, *SD* = 1.97), p = .097. If the synchrony was first, there was not a significant difference between synchronous (*M* = 1.05, *SD* = 1.63) and asynchronous (*M* = 0.81, *SD* = 1.78) manipulations, *p* = .68. When the prime was friendship, we did not see significant effects of synchrony both when the synchronous stimulation was first ($M_{Synchrony}$ = 0.89, $SD_{Synchrony}$ = 2.31,

M_{Asynch} = 1.16, SD_{Asynch} = 1.89, p =.661), and when the asynchronous stimulation was first, ($M_{Synchrony}$ = 1.24, $SD_{Synchrony}$ = 1.90, M_{Asynch} = 0.43, SD_{Asynch} = 1.89, p = .158) (Results are summarized in **Figure 7.4**).

With regard to the face illusion variables, the order of the stroking influenced the results. Thus, when the synchronous manipulation condition: ownership ($M_{\text{Synchrony}}$ = - 0.31, $M_{\text{Asynchrony}}$ = -1.58, $t(58)$= 5.533 , $p < .001$), location ($M_{\text{Synchrony}}$ = 0.40, $M_{\text{Asynchrony}}$ = -1.31, $t(58)$ = 9.22 , $p < .001$), agency ($M_{\text{Synchrony}}$ = -0.38, $M_{\text{Asynchrony}}$ = -1.41, $t(58)$ = 5.48 , $p < .001$) showed significant differences but not affect ($M_{\text{Synchrony}}$ = 1.26, $M_{\text{Asynchrony}}$ = 0.56, $t(58)$ = 1.34 , p = .19) .

When asynchrony came first, a significant difference was found for location ($M_{\text{Synchrony}}$ = 0.58, $M_{\text{Asynchrony}}$ = -0.06, $t(56)$ = -3.41, p = .001) and agency ($M_{\text{Synchrony}}$ = -0.94, $M_{\text{Asynchrony}}$ = -0.48, $t(56)$ = -2.43, p = .018) , but not for ownership ($M_{\text{Synchrony}}$ = -0.45, $M_{\text{Asynchrony}}$ = -0.68, $t(56)$ = -1.32, p = .19) nor affect ($M_{\text{Synchrony}}$ = 0.94, $M_{\text{Asynchrony}}$ = 0.98, $t(56)$ = -0.524, p = .602).

For the physical resemblance variables, there was a significant difference when synchrony came first for the general resemblance variable ($M_{\text{Synchrony}}$ = 3.21, $M_{\text{Asynchrony}}$ = 2.90, $t(58)$ = 2.30, p = .025), but not for the core ($M_{\text{Synchrony}}$ = 2.77, $M_{\text{Asynchrony}}$ = 2.78, $t(58)$ = -0.072, p = .943) and peripheral ($M_{\text{Synchrony}}$ = 3.12, $M_{\text{Asynchrony}}$ = 2.83, $t(58)$ = 1.66, p = .103) facial features. When the asynchronous stroking came first, there were no significant differences, ps > .05.

The type of multisensory stimulation did not have a significant effect on the liking variable, $p > .05$. The same pattern occurred independently of the order, ps > .05.

There was a significant difference when synchrony was first in the overlap variable ($M_{\text{Synchrony}}$ = 2.53, $M_{\text{Asynchrony}}$ = 2.15, t (58) = 2.38, p = .02) and also when asynchrony was first ($M_{\text{Synchrony}}$ = 2.68, $M_{\text{Asynchrony}}$ = 2.42, t (56) = -2.04, p = .046).

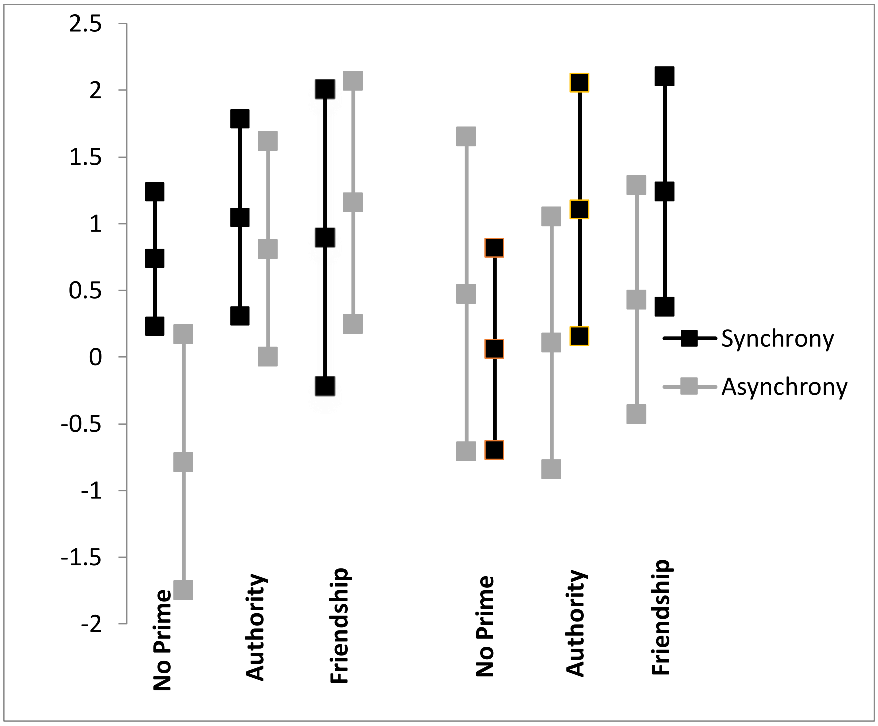


Figure 7.4**:** 95% Confidence Intervals of Trustworthiness recognition according to type of stroking (synchrony vs asynchrony), order (Synchrony vs Asynchrony/ Asynchrony vs Synchrony) and Prime (Authority vs Friendship vs No Prime).

7.10 Discussion

The central prediction of Study 2 was confirmed: When participants had to identify the person with whom they shared a synchronous or an asynchronous stimulation, they selected a more trustworthy version after they received a synchronous stimulation compared to when they received an asynchronous stimulation. Thus, the synchronous stimulation biased their memory for the face towards more trustworthiness. Selecting a morph of that face that contains more trustworthiness is similar to selecting a version that shows signs of facial expressions indicating a smile.

We did not find that the influence of synchrony depended directly on whether participants first thought about friendship, authority, or no context. Instead, primings of both social contexts led to more trustworthiness selection compared to the neutral prime. More interestingly, however, was that priming interacted with synchrony depending again on order. The pattern of this interaction confirmed the findings of Study 1. When no relationship context was primed (i.e., conditions were as in Study 1), synchrony led to more trustworthiness selection only when it came first, not when it came second. That was not the case in the friendship condition. In the authority condition, means were actually marginally reversed. This suggests that the order effect found in Study 1 was not a fluke, and order deserves a more comprehensive investigation in future studies. Moreover, when the synchronous stimulation came first, there were differences across more variables related to the face illusion than when the asynchronous stimulation came first. Similarly, the general resemblance variable showed only significant differences when the synchronous condition came before the asynchronous one. In addition, it is clear that the relationship priming created a stronger influence than the order effects, and thereby removed them. It seems that activating any kind of relationship schema results in stronger trustworthiness ratings. This is an interesting and unexpected result that should be investigated further.

7.11 General Discussion

Recent studies showed that a synchronous multisensory stimulation can have an effect on social judgments by blurring of self-other boundaries and instigating a social relation (Mazzurega et al., 2011; Paladino et al., 2010). In the present research we investigated whether such effects stretch to impression formation and memory for another person's face. We found that under specific conditions, sharing a synchronous stimulation (compared to shared asynchronous stimulation) can lead participants to judge the other's face, and faces similar to the other, as more trustworthy (Study 1), and remember the other's face as more trustworthy than it really was (Study 2). Thus, the effects of synchrony can go beyond the bond felt to the synchronously stimulated person and changes to the self-concept, and actually render one's impression and memory of a synchronously stimulated other more trustworthy.

Our data show that people if synchrony has an effect on the impression of a target person, this effect generalizes to similar faces. As the data from 35% morphs of the target faces demonstrate, these morphs were also judged as more trustworthy when the participants were in synchrony with the target face that was part of the morphs. Previous work by Zebrowitz and collaborators (1997) has shown that we tend to prefer persons that resemble people that we consider important in our lives. These results show that an embodied manipulation (i.e. a synchronic rhythmic movement) can change the judgment of faces and, consequently, drive our face preferences for similar ones.

However, this effect only occurred when the synchronous stimulation was experienced before the asynchronous stimulation. In Study 1, when the asynchronous condition was experienced first, the synchronic rhythmic movement did not influence the judgments of trustworthiness of faces. The lack of a social judgment effect in this order condition was accompanied by less enfacement illusion in the first place. In the Study 2, the effect of synchrony was significant across the various conditions. However, we did find that order of synchrony versus asynchrony mattered also in Study 2. When no additional priming of a social relation was implemented, a reliable difference between synchrony and asynchrony was again only found when synchrony came first. Thus, in both studies, we found unexpected moderations of our effects by the order in which synchrony and asynchrony were experienced, if no additional relational context could override the order effect. Such interactions have been reported only by Tajadura-Jiménez et al. (2012b) before, and only in passing. To our knowledge, other previous studies using this design never reported such interactions or even their tests, possibly because of much smaller cell sizes and accompanying lack of power (e.g., Paladino et al. 2010), but simply reported main effects. We only found the social effects when synchrony came first. Then, the following asynchronous others were judged and remembered as less trustworthy. However, when asynchronous experiences came first, the following synchrony did not matter much. In ongoing work, Toscano, Schubert & Waldzus (2014) found a similar effect of order using a different paradigm. There, we observed that synchrony of two target persons has a larger impact on their perceived entitativity when it comes before asynchrony.

One possibility is that synchrony is an unexpected cue in the absence of a pre-established relationship. When asynchrony comes first, attention is given to a host of other cues, and judgments are tuned to this condition. If synchrony comes after it, it is not taken into additional account. However, if synchrony comes first, it captures all attention, and its lack in the subsequent condition leads to a considerable decrease. Therefore, it seems that the absence of synchrony in the first trial is not diagnostic.

However, when participants are primed with a relational context, we see a different pattern of order effects. The differences between synchrony and asynchrony are larger when the asynchronous condition comes first, possibly because the prime creates a relationship context. When asynchrony comes first in such a context, the absence of synchrony becomes diagnostic These order effects deserve to be taken seriously in future research, and possibly in re-analyses of existing data.

One potential limitations of our study was that we only recruited female participants in Study 2. However, previous studies did not reveal gender differences in the enfacement illusion or its downstream consequences (see Tajadura-Giménez et al., 2012b).

In sum, we find that the effects of experiencing multimodal synchrony with another person, and the accompanying enfacement illusion of merging bodily representations, can have effects on how trustworthy the person is judged to be and remembered to look like. However, these effects depend on the relational context, and if none is given, the order of the manipulations itself can provide such a context. The effects go even beyond the face one saw, and also affect faces that resemble it.

Previous studies showed that synchrony can lead to the formation of a common identity, increase cooperation and influence social perception (Fiske, 2004; Paladino et al.; Wiltermuth & Heath, 2009). Our findings extend this notion by suggesting that processes of synchronous multisensory stimulation can lead in some cases to inter-individual differences in face evaluation and memory. For instance, watching oneself in the mirror essentially resembles a multisensory synchrony experience with the face seen in the mirror – one’s own. This experience may explain partly why we like our own faces. Furthermore, experiencing behavioral synchrony with close others is more likely, and again this can have effects on judged trustworthiness on similar faces in the manner found here. Thus, multisensory synchrony may actually influence face evaluation processes in daily life.

CHAPTER 8

AN EMBODIED APPROACH TO FACE EVALUATION: MAIN FINDINGS AND LIMITATIONS

The main objective of this dissertation was to demonstrate the pivotal role of our bodies' actions in forming impressions based on faces. To accomplish this, I extended face evaluation from the theoretical framework of the ecological approach (Zebrowitz, 2011; Zebrowitz et al., 2011) to embodied cognitive theories (e.g. Schubert & Semin, 2009).

During the last few years, studies on face evaluation have been receiving much attention (see Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2014). According to some authors (Oosterhof & Todorov, 2008; Sutherland et al., 2013) two of the dimensions underlying facial judgments are trustworthiness and dominance. These trait dimensions serve a functional role because they transmit to the perceiver the intentions (e.g. whether a person is trustworthy enough for me to engage with him/her) and the ability to apply those intentions (e.g. whether, as an ally or competitor, a person is sufficiently socially relevant). Consequently, it is essential to detect quickly if someone is trustworthy or dominant in order to determine the relational and interactional possibilities.

However, in the literature the connection between face evaluation and action has been treated as unidirectional, and the functions considered have been rather broad and abstract (e.g., caring for others). In this dissertation, my intention was to emphasize that face perception has a bidirectional relation with action, and that the functional role also is connected to concrete, bodily interactions. Facial perception is tied to action in a way that influences how we should act with our bodies. In other words, central concepts of face perception and impression formation, namely dominance and trustworthiness, are derived from and grounded in physical interactions with the social environment. In addition, our conceptual representations of these concepts are modal, and include motor and perceptual content. As a result, the way our bodies act can influence how we perceive faces. In sum, the present dissertation aimed to show that not only face perception is for doing, as posited by the ecological approach (see Zebrowitz, 1997), but that doing might change how we perceive faces, picking up the central claims of the field of embodied cognition, namely that our bodies support and influence cognition (see Schubert & Semin, 2009). Given the substantial role played by sensory-motor processes in cognitive processing, I wanted to demonstrate that face evaluation is directly connected to bodily action, that is, it is embodied (e.g. Glenberg, 2010; Schubert & Semin, 2009).

Based on the notion that facial evaluation serves action which results from bodily interactions, I developed an empirical research program described here in six chapters. In developing the experiments, I used a mixture of data-driven methods (Dotsch et al, 2008; Dotsch & Todorov, 2012; Oosterhof & Todorov, 2008; Todorov & Oosterhof, 2011), embodiment paradigms, and specific software for the generation of stimuli (FaceGen software, Facegen Modeller program version 3.5, http://facegen.com). Generally, the results have indicated that face evaluation is functionally adaptive and bodily states influence facial evaluation. In the next sections, I will summarize the findings and implications for the literature of face evaluation.

8.1 Summary of the Findings

8.1.1 Face Evaluation is for Action – "Perceiving is for doing"

In the first three empirical chapters (**Chapters 2, 3 and 4**), I presented experiments designed to study whether facial dominance is connected directly to, or grounded in, action. More specifically, my goal was to investigate in a more thorough way whether dominance judgments from faces are indeed related with the perception of cues associated with the ability to apply intentions (Oosterhof & Todorov, 2008). Previous research had already posited that dominance judgments were likely the result of physical strength cues overgeneralization (Oosterhof & Todorov, 2008; Sutherland et al., 2013). Moreover, other researchers (Sell, Cosmides, et al., 2009) were able to show that participants were capable of accurately judge the actual strength of a person based only on their faces. Nonetheless, the empirical relation between social dominance and physical strength was empirically absent from the literature. Therefore, I wanted to demonstrate that the dominance dimension may result from the perception of physical strength cues that signal to the perceiver the potential of someone to put in action what he/she intends. Consequently, facial dominance evaluation may also help the perceiver to know how to act in order to face or avoid physical fights and to navigate social hierarchies given the ability to recognize who is potentially more influential (Parker, 1974).

Based on this, in the first two experiments (**Chapter 2**), I tested whether perceived physical strength from faces predicted judgments of dominance. Using computer-generated and natural faces, I asked the participants to judge faces on physical strength and dominance. I demonstrated that judgments of dominance were predicted by judgments of physical strength. Moreover, both judgments were highly correlated. In line with this, I also found common facial predictors for both judgments. The regions of the face that seemed to predict both physical strength and social dominance were the brows and eye regions as well as the chin and nose areas. These experiments enabled me to show that social dominance seems to result from an overgeneralization of physical strength cues.

In the next study (**Chapter 3**), my goal was to see how similar the visual representations of social dominance and physical strength in the human face are to each other. I used for this study a data-driven approach (Dotsch & Todorov, 2012; Jack, Caldara, & Schyns, 2012; Oosterhof & Todorov, 2008; Todorov et al., 2013; Todorov & Oosterhof, 2011; Walker, Jiang, Vetter, & Sczesny, 2011; Walker & Vetter, 2009). First, the participants had to judge 300 computer-generated faces (Oosterhof & Todorov, 2008). As in **Chapter 2**, physical strength judgments were related to dominance judgments. After that, I was able to visualize across the levels of physical strength and dominance judgments that both judgments were very similar. Therefore, using a data-driven approach I was able to visualize that dominance and physical strength representation for both genders change in a similar fashion. The facial regions that seemed to change along the physical strength and dominance visual representation were the eyes and chin length, eyebrow height and width of nose and face. This is consistent with the results of **Chapter 2**. Moreover, masculinity and anger expressions seemed to increase when faces become both more dominant and physically stronger.

In the next phase of this study, I wanted to empirically confirm whether participants could discriminate dominance and physical strength from each other. Using a two-forced choice paradigm, I asked participants to select from a pair of faces which one looked more dominant or physically stronger. These pairs of faces were constituted of a face from the model of dominance and another face from the physical strength model. The results showed that participants were not better than chance. Thus, participants were not able to discriminate (representations of) social dominance and (representations of) physical strength from each other. This seemed to indicate that social dominance is intrinsically related with physical strength. However, this data-driven approach also enables us to maximize the differences between judgments. As a result, it was possible to differentiate strength from dominance and create faces that were dominant but physically weak and extremely strong but non dominant. Using these faces, I asked again in a two-forced choice paradigm to select which face was more dominant or physically stronger. When the participants were presented with faces that maximized the differences between physical strength and dominance, I found that when participants were asked to select the stronger face, they accurately selected the physical strong (but non dominant) instead of the dominant (but physically weak) face. This pattern was the same for both female and male faces. However, when they had to select the more dominant face the pattern was not exactly the same. For female faces, the participants were, generally, accurate, choosing more often the dominant (but physically weak) face as more dominant than the physically stronger (but non dominant) face. But for male faces, participants tended to select the physically stronger (but non dominant) face in more cases than the dominant (but weak) face. These results indicate that physical strength can be distinguished from dominance, but that dominance, particularly for men, seems to be inherently connected with physical strength and it is hard to distinguish from it.

In line with the notion that physical strength predicts dominance, I explored in five studies (**Chapter 4**) how dominance and physical strength judgments may change according to gaze direction and head position. My goal was to show that physical strength cues are used for dominance judgments across different head positions and gaze directions. The pattern of results showed that dominance and physical strength change in a similar way through the levels of gaze direction and head position. Generally, faces with direct gaze and seen from above and below positions were judged as stronger and more dominant. However, the interaction between gaze direction and head position was larger for dominance judgments than for physical strength judgments. Additional findings suggest that the profile of physical strength and dominance across the different head positions and gaze directions might be related to the expression of anger cues. As in **Chapter 3**, the trend was that as faces became more dominant and physically stronger they expressed more anger. Given these findings, I was able to show that, to some extent, anger judgments have some resemblance to the pattern of judgments of dominance and physical strength across head position and gaze direction. Importantly, the judgments of physical strength were correlated with judgments of dominance across every head position and gaze direction.

Overall, the pattern of findings of the studies designed in chapters 2, 3 and 4 showed that people use cues of physical strength to arrive at social dominance judgments. In the first three empirical chapters of this thesis, I was able to show that dominance judgments from faces seem to be, in part, based on the overgeneralization of physical strength cues. Therefore, I added evidence to one of central tenets of the ecological approach which posits that trait impressions from faces offer to the perceiver cues to act adaptively (e.g. Zebrowitz, 2011; Zebrowitz et al., 2011). In this case, the perception of physical strength tells the perceiver something about the other's ability to impose costs (Sell et al., 2009). Perceiving strength would influence our bodily actions given that physical strong persons are more prone to became angry and aggressive. Moreover, stronger people win more physical fights and judge themselves as more entitled (Sell et al., 2009). Therefore, the overgeneralization of physical strength cues seems to afford the perceiver to act adaptively because enabled throughout our evolutionary past the identification of people that were potentially more influential, resourceful and more able to apply intentions (Parker, 1974).

8.1.2 Bodily States and Face Evaluation

In the first three empirical chapters, I was able to demonstrate that face evaluation is intrinsically associated with adaptive action. More specifically, facial dominance is related to the perception of cues of physical strength. Thus, we perceive someone as dominant because her or his face has properties that signal her or his ability to apply intentions. Consequently, this may influence our bodily actions. If we know that some person has the capacity to apply intentions, our behavior may change. Therefore, face perception "is for doing" (e.g. Zebrowitz, 2011). As a threatening face may lead us to avoidance actions, and a babyface influence us to act in a friendlier way (e.g. Zebrowitz, 2011), the perception of a physical strength face may help us to navigate through social hierarchies and whether or not to confront someone. However, these empirical chapters do not tell the whole story about the potential role of bodily actions in face evaluation.

These findings only demonstrate that dominance is interrelated with physical strength which signals someone's ability to pursue his intentions. Therefore, it shows only that dominance perception is related to how our bodies may act potentially and in a circumscribed way, but it tells us little about the modality and embodied nature of the representations of dominance. That was the goal of the last three empirical chapters (**Chapters 5, 6 and 7**): to identify how bodily actions could influence how we perceive faces, and to therefore show the embodiment of dominance representations. To test this, I developed experiments where I manipulated bodily postures (**Chapters 5 and 6**). Furthermore, I extended this reasoning beyond dominance and to trustworthiness, which is the other important dimension of face perception. There, I tested the impact of interactions between bodies (**Chapter 7**).

In the experiment of **Chapter 5**, I explored whether embodied power has an effect on the perception of facial dominance. I manipulated power through bodily postures (expansive vs. constrictive). The results of the study suggest that the manipulation of posture influences the perception of social dominance. More specifically, posing in a powerful posture leads to a reduction of perceived differences in facial dominance compared to a submissive posture. Participants who were in an expansive posture felt more powerful and perceived fewer differences between levels of facial dominance compared to participants in a constrictive posture. Therefore, bodily feedback may alter the perception of facial dominance.

Additional evidence for the role of bodily states on face perception was shown in the experiment of **Chapter 6.** Using the same manipulation as the one used in **Chapter 5**, participants were in an expansive or constrictive posture. I was able to show that the mental representation of the own face was changed by bodily states. Besides the bodily postures manipulation and in order to generate a mental representation of the own face, I used a reverse correlation paradigm (e.g. Dotsch et al., 2008). In the reverse correlation task, participants had to select from two faces the one that resembled them more. Participants who displayed a dominant posture (expansive) generated classification images of their own face that were considered more dominant than the images participants displaying a submissive posture (constrictive) generated. Therefore, it seems that the bodily feedback from postures plays a role for the mental representation of our own facial representation.

The last empirical chapters showed that the way our bodies pose seem to change face perception. However, these chapters did not look whether the interaction between bodies changes the evaluation of faces in terms of trustworthiness. In the last empirical chapter (**Chapter 7**), I studied how experiencing synchrony with another person influences face evaluation. I designed two experiments based on the notion of the *enfacement effect* (e.g. Tsakiris, 2008). This effect occurs when experiencing a synchronous stimulation of one's cheek while seeing someone else's face is touched in a synchronous way. This typically leads to cognitive and social-cognitive effects resembling self-other merging. In two studies, I demonstrated that this multisensory stimulation can change the evaluation of faces. In the first study, participants judged the target face and similar faces as being more trustworthy after synchrony, but not after asynchrony. This effect interacted with the order of the stroking, such that only when the synchronous stimulation occurred before asynchrony was the trustworthiness significantly changed. In the second study, a synchronous stimulation caused participants to remember the other's face as more trustworthy, compared to the asynchronously stimulated target. The results of both studies show that a shared synchronous rhythmic experience can alter the trustworthiness judgments of faces.

Overall, my findings indicate that face evaluation might be influenced by bodily conditions. The role of embodied cognition has been absent in the literature of previous models of face perception (see Zebrowitz, et al., 2011). However, I showed that embodied mechanisms, such as bodily postures and synchronous rhythmic movement, might also play an important role in face evaluation. In sum, the results suggest that face evaluation might be, to some extent, embodied.

8.2. Limitations

8.2.1 Dominance and the Overgeneralization of Physical Strength

These studies indicate that dominance perception derives from the need to perceive physical strength. However, the data also suggests that people go beyond physical strength cues in order to make dominance judgments. Physical strength was and still is a fundamental heuristic to judge social dominance (Toscano, Schubert, & Sell, 2014). However, certain skills associated with social dominance such as the ability to lead and solve cognitive problems do not seem to be intrinsically related to physical strength. As a result, not only physical strength, but cognitive skills that increase the influence of someone are both important to attain social dominance (Cheng et al., 2013; Henrich and Gil-White, 2001; Von Rueden et al., 2011). Consistent with this, the results of **Chapter 2** demonstrated that dominance judgments were not correlated with actual physical strength when controlling for judgments of physical strength. Moreover, certain facial features predicted dominance, but not physical strength and vice-versa.

The data-driven approach that was conceived in **Chapter 3** also revealed that it is possible to generate faces that differentiate the two trait dimensions. This allowed the participants to discriminate physical strength from dominance. However, the discrimination of dominance from physical strength was only possible for female faces, but not for male ones. Overall, this suggests that physical strength and dominance can be visually distinct and that dominance judgments may derive from other cues besides physical strength ones. Nonetheless, it seems that people have some difficulty in dissociating dominance and physical strength, in particularly, for male faces. Therefore, the results seem to suggest that physical strength and social dominance may be more intrinsically connected in males. For females, other traits seem to play a larger role for social dominance. According to some authors (Sell et al., 2009) attractiveness, but not physical strength, is related more strongly to social dominance of women.

In the last empirical chapter (**Chapter 4**), considering the notion that dominance judgments may result from the overgeneralization of physical strength cues, I found that dominance and physical strength judgments change in a similar way according to gaze and head position. Nonetheless, the effects of gaze direction and head position, as well as the interaction between them had a larger effect on dominance than on physical strength judgments. In line with the reasoning described above, it seems that people go beyond physical strength information to judge dominance.

Moreover, with correlational analysis it is hard to identify whether there is a causal relationship between physical strength and social dominance. As a result, the hypothesis that the direction of causation between physical strength and dominance is reversed cannot be ruled out. However, it is unlikely that people would detect an abstract characteristic (i.e. dominant trait) and overgeneralize to concrete information (i.e. physical strength trait). It is much more likely that we would overgeneralize from information that is factual (i.e. physical strength) and then overgeneralize to make abstract judgments (i.e. dominant trait). In addition, the asymmetric pattern identified in **Chapter 3** suggests that strength can be distinguished from dominance, but dominance is harder to distinguish from strength.

In sum, dominance perception is based on the overgeneralization of physical strength. However, my data by no means indicates that physical strength is the same as social dominance. It seems that dominance evaluation is an elaboration of, and grounded in, the perceptual systems' adaptive functioning, derived from the necessity to perceive physical strength cues.

8.2.2. Face Evaluation: Can Bodily states change Face Evaluation?

The main goal of the last three empirical chapters (**Chapters 5-7)** was to demonstrate that bodily states change impressions from faces. The underlying reasoning was that such tests are the standard way to show the embodied nature of cognitive processes. If manipulations of the body influence a cognitive process, then that cognitive process must in some way include bodily input and variables. My results showed that bodily postures (expansive vs. constrictive) influenced the way we perceive differences between levels of dominance (**Chapter 5**). Additionally, bodily feedback also led the participants to change the mental representation of their own faces (**Chapter 6**). Moreover, the interaction between bodies (e.g. synchronous multisensory stimulation) changes the judgments and recognition of facial trustworthiness (**Chapter 7**).

These studies provided additional evidence of a larger role for bodily actions in the evaluation of faces. However, the results may raise one important question: were the effects of bodily postures really mediated by embodied processes? One alternative explanation that is often offered for such evidence is that the effects of the bodily manipulations could be driven by semantic priming (Strack, Martin, & Pepper, 1988). The concept of power may have been primed during the procedure. However, this hypothesis seems unlikely given that participants did not, at least, report related suspicions when they were asked to describe the experiment goals. Therefore, it does not seem likely that conscious inferences played a role in the results. However, some self-perception theory researchers (e.g. Laird, 2007) posit that we can make inferences that are not accessed consciously from our own behaviors. These inferences are unconscious and automatic. My results can be explained by unconscious self-perception as well as embodiment theories.

Nonetheless, it is hard to disentangle the unconscious self-perception theoretical framework from embodiment because it is, usually, mentioned as one the foundations for embodiment itself (Niedenthal et al., 2005; Schubert & Koole, 2009).

Overall, the data suggests that bodily feedback influences face evaluation. As a result, face perception seems to be not only for doing. Our bodily behaviors seem to influence face perception. In his original work, Gibson (1966) had already stated the importance of action for perception. In the literature on face perception, several contributions showed the importance of bodily feedback mechanisms in evaluative processes (e.g. Ito, Chiao, Devine, Lorig, & Cacioppo, 2006; Strack et al., 1988). Nonetheless, the importance of bodily states in the formation of impressions from faces seem to be absent in the literature. The results described in this thesis contribute a new line of research on face evaluation that is based in embodied mechanisms.

Conclusion: A Summary

This thesis presents several studies that represent a line of research that integrates the relation between perception and action in face evaluation (Oosterhof & Todorov, 2008; Zebrowitz, 1997, 2011; Zebrowitz et al., 2011) with embodied cognition theories (e.g. Barsalou, 2008; Glenberg, 2010; Niedenthal, 2007; Schubert & Semin, 2009). My goal was to provide evidence for the notion that face perception influences our potential actions, that is, "perceiving is for doing" (e.g. Gibson, 1966; Zebrowitz, 1997, 2011; Zebrowitz et al., 2011). However, Gibson (1966) drew attention to the notion that not only does perception influence bodily behavior, but also bodily states may influence perception. Follow this line of reasoning; I demonstrated the role of bodily actions in face evaluation.

Similarly to the ecological approach to face perception (Zebrowitz, 2011; Zebrowitz et al., 2011), the results confirmed that impressions from faces may influence our subsequent actions. Moreover, the findings of the present thesis demonstrated a bidirectional relationship between bodily action and face evaluation. This research indicates that face evaluation may be embodied.

Nonetheless, the bidirectional relationships between action and face evaluation need more integration and specification. My results are just a first contribution on these processes.

Nonetheless, this thesis shows in a consistent way how impressions from faces are, in part, grounded in mechanisms related with bodily actions.

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