universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master Thesis

Women's Perception of Male Facial Attractiveness in Association with Handgrip Strength: Averageness is Most Attractive in a Cross-Cultural Context

verfasst von / submitted by

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angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien 2020/ Vienna 2020

Studienkennzahl lt. Studienblatt / Degree programme code as it appears on the student record sheet:	UA 066 827
Studienrichtung lt. Studienblatt / Degree programme as it appears on the student record sheet:	Masterstudium Anthropologie Masterprogramme Anthropology
Betreut von / Supervisor:	Ao. Univ.-Prof. Mag. Dr. Katrin Schäfer
Mitbetreut von / Co- Supervisor:	Mag. Dr. Sonja Windhager

Acknowledgements

First of all, I would like to express my very great appreciation to Prof. Katrin Schaefer for the support of my master thesis and giving advice. Also, I would like to offer my special thanks to Dr. Sonja Windhager for giving support and finding a solution to every single problem. I believe that I had a piece of luck having such great supervisors and having learned from them a lot.

Thanks for the help of Prof. Ecevit Barış Özener, who helped me to get permission to collect data in Istanbul and gave pieces of advice.

Additionally, I would like to thank all the participants. Without the help and interest of those 213 women, writing this master thesis would not be possible.

I am also grateful to my mother who has always supported me morally and economically. Most special thank goes to my father, who made me who am I today with all the positives and negatives. I am happy that I was his daughter.

Thanks to my college Esra Yaman, with whom I started this adventure. She has been always with me.

Last but by no means least, very special gratitude goes out to my boyfriend Mag. Wolfgang Seiser for his encouragement all those years, who became not only my partner but also my best friend.

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Abstract

The human face shows emotions and personality traits, and this diversity is observable and quantifiable. Humans can even recognise physical strength in face of a conspecific and perceived strength may be related to physical attractiveness as formidability indicator in men. On the other hand, extreme features are usually less desirable. This might be modulated by culture, relationship status and conception risk of female raters. For women rating male faces, it was hypothesized that (1) perceived strength matches actual strength, (2) that the average morph is most attractive, (3) Austrian and Turkish women agree in their attractiveness assessments, (4) during a phase of high conception risk, stronger men are perceived more attractive than weaker ones, and (5) partnered women prefer stronger men than single women.

Five frontal facial morphs of young adult German men (mean age= 24 y., *SD* = 3.7 y.) from a previous study calibrated by handgrip strength were presented in random order to 104 Austrian (mean age = 22 y., *SD* = 2.5 y.) and 109 Turkish (mean age = 20 years, *SD* = 1.9 y.) female university students in Vienna and Istanbul. Using on-screen sliders, they rated each morph for various traits of which only perceived attractiveness and perceived strength was used in the current study. Additionally, the participants were asked about their length and current status of relationship with men, as well as their regularity, length and last date of their menstrual cycle. A repeated-measures analysis of variance (ANOVA) test was performed for null hypothesis testing.

The results showed that the weakest morph was perceived significantly weaker than the second weakest, and all others scored significantly higher ($F = 43.7$, $p < 0.001$). For attractiveness, the average morph was perceived considerably ($p < 0.001$) more attractive than the others except for the second weakest morph ($F = 59.8$, $p < 0.001$). Austrian and Turkish perceptions were systematically different ($F = 8.9$, $p = 0.003$): On average, Austrian participants gave higher ratings to every morph. There were no differences between partnered and single Austrian ($p = 0.708$) and Turkish ($p = 0.878$) women in the attractiveness ratings as well as within Austrian ($p = 0.405$) and Turkish ($p = 0.184$) participants in different menstrual cycle phases.

This study confirmed that women could largely assess physical strength from facial shape presented via calibrated morphs. In line with predictions of trade-offs coined in

evolutionary aesthetics, the female participants preferred the average morphs over the stronger and weaker ones, irrespective of their cultural background. This might represent a balance between aggression avoidance, physical fitness, resource holding potential and parenting qualities. Different interpretations of the light skin tone might account for the slightly lower attractiveness rating in Turkey. Menstrual cycle phase had no impact on perception of male facial attractiveness in relation to body strength but this might be due to very low numbers of women at high conception risk. Also, the subjective interpretation of relationship status as well as individual differences in sociosexuality might mediate facial preferences, and thus contribute to the null finding in this study. Generally, the application of the calibrated morphs confirmed averageness as a pillar in evolutionary explanations of attractiveness.

Zusammenfassung

Das menschliche Gesicht zeigt Emotionen und Persönlichkeitsmerkmale und diese Vielfalt ist beobachtbar und quantifizierbar. Menschen können sogar körperliche Stärke ihrer Artgenossen erkennen und wahrgenommene Stärke kann mit körperlicher Attraktivität als bedeutender Indikator bei Männern in Zusammenhang gebracht werden. Andererseits sind extreme Merkmale generell weniger erwünscht. Dies könnte durch die Kultur, den Beziehungsstatus und das Empfängnisrisiko weiblicher Bewerterinnen moduliert werden. Für Frauen, die männliche Gesichter bewerten, wurden die Hypothesen aufgestellt, dass (1) die wahrgenommene Stärke mit der tatsächlichen Stärke übereinstimmt, (2) dass der durchschnittliche Morph am attraktivsten ist, (3) österreichische und türkische Frauen in ihren Attraktivitätsbewertungen übereinstimmen, (4) während einer Phase eines hohen Empfängnisrisikos, werden stärkere Männer attraktiver wahrgenommen als schwächere und (5) Frauen in einer Beziehung bevorzugen stärkere Männer im Gegensatz zu alleinstehenden Frauen.

Fünf frontale Gesichtsmorphs junger deutscher Männer (Durchschnittsalter = 24 Jahre, *SD* = 3,7 Jahre) aus einer früheren Studie, kalibriert nach Handgriffstärke, wurden 104 österreichischen (Durchschnittsalter = 22 Jahre, *SD* = 2,5 Jahre) und 109 türkischen (Durchschnittsalter = 20 Jahre, *SD* = 1,9 Jahre) Studentinnen in Wien und Istanbul in zufälliger Reihenfolge präsentiert. Mithilfe von Bildschirmreglern bewerteten sie jedes Morph zu verschiedenen Merkmalen, von denen in der aktuellen Studie nur die wahrgenommene Attraktivität und die empfundene Stärke verwendet wurden. Zusätzlich wurden die Teilnehmerinnen nach ihrer Länge und dem aktuellen Status der Beziehung zu Männern sowie nach ihrer Regelmäßigkeit, Länge und dem letzten Datum ihres Menstruationszyklus befragt. Für den Nullhypothesentest wurde ein Varianzanalyse-Test (ANOVA) mit wiederholten Messungen durchgeführt.

Die Ergebnisse zeigten, dass der schwächste Morph signifikant schwächer wahrgenommen wurde als der zweitschwächste und alle anderen signifikant höher abschnitten ($F = 43{,}7$, $p < 0{,}001$). In Bezug auf Attraktivität wurde der durchschnittliche Morph mit Ausnahme des zweitschwächsten Morphs ($F = 59{,}8$, $p < 0{,}001$) erheblich attraktiver wahrgenommen als die anderen ($p < 0{,}001$). Wahrnehmungen von Österreicherinnen und Türkinnen waren systematisch unterschiedlich ($F = 8{,}9$, $p = 0{,}003$): Im Durchschnitt gaben

österreichische Teilnehmerinnen jedem Morph höhere Bewertungen. Bei den Attraktivitätsbewertungen gab es weder Unterschiede zwischen Frauen, die sich in einer Beziehung befanden und alleinstehenden österreichischen (p = 0,708) und türkischen (p = 0,878) Frauen noch bei österreichischen (p = 0,405) und türkischen (p = 0,184) Teilnehmerinnen in verschiedenen Menstruationszyklusphasen.

Diese Studie bestätigte, dass Frauen die körperliche Stärke weitgehend anhand der Gesichtsform beurteilen konnten, die über kalibrierte Morphe präsentiert wurde. In Übereinstimmung mit Vorhersagen von Trade-offs, die in der evolutionären Ästhetik geprägt wurden, bevorzugten die weiblichen Teilnehmerinnen die durchschnittlichen Morphen gegenüber den stärkeren und schwächeren, unabhängig von ihren kulturellen Hintergründen. Dies könnte ein Gleichgewicht zwischen Aggressionsvermeidung, körperlicher Fitness, Ressourcenhaltepotential und Elternqualitäten darstellen. Unterschiedliche Interpretationen des hellen Hautfarbtons könnten für die etwas niedrigere Attraktivitätsbewertung in der Türkei verantwortlich sein. Die Menstruationszyklusphase hatte keinen Einfluss auf die Wahrnehmung der männlichen Gesichtsattraktivität in Bezug auf die Körperkraft. Dies könnte jedoch auf eine sehr geringe Anzahl von Frauen im Empfängnisrisiko zurückzuführen sein. Auch die subjektive Interpretation des Beziehungsstatus sowie individuelle Unterschiede in der Soziosexualität könnten Gesichtspräferenzen vermitteln und somit zum Nullbefund in dieser Studie beitragen. Im Allgemeinen bestätigte die Anwendung der kalibrierten Morphe die Durchschnittlichkeit als Säule in evolutionären Erklärungen der Attraktivität.

1. Introduction

Facial features of humans alone give reliable signals to other people about the hormonal profiles as well as personalities and characteristics of individuals. Understanding these signals and finding the reasons therein are important for humans as well as science because they help humans to find the ideal mate, the right person to trust or invest in his/her life etc. The following study examines and discusses these signals and their effects.

1.1 Perception of Physical Strength

The actual physical strength of men and women plays an important role in the perception of attractiveness, masculinity, femininity, dominance, aggressiveness etc. Physical strength is an important reason for these signals to become manifest through different hormonal levels.

The evolutionary history of humans has made male and female characteristics dissimilar. According to Rice (1984), natural selection is the reason for sexual dimorphism, which makes some phenotyping features different between sexes. Many species including Homo sapiens exhibit sexual dimorphism (Plavcan, 2001; Rice, 1984). Scientists describe sexual dimorphism such that men have more muscles, are stronger than women (Frayer & Wolpoff, 1985). Furthermore, scientists characterize faces of men with protruding cheekbones and brow ridges as well as a larger jaw as opposed to women's faces with fuller lips and smaller mouth (Fink et al., 2005; Penton-Voak et al., 2001).

Different hormonal factors are responsible for such sexually dimorphic features. For example, evolutionary anthropologists and psychologists show that the level of testosterone, especially during the prenatal period, influences the facial features of men (Schaefer et al., 2009), whereas during puberty hormonal changes influences the fundamental features (Johnston et al., 2001).

Male-like facial features are highly related to a high testosterone level. Those facial features and actual physical strength are positively correlated with the medical health of men, fighting ability, resource-holding potential and also partly with reproductive success based on a high testosterone level (Rhodes et al., 2005; Puts, 2010; Parker, 1974). Importantly, the handgrip strength differs between genders and correlates with the testosterone level (Gallup et

al., 2010). In addition, handgrip strength is highly correlated with total muscle strength (Wind et al., 2010), explaining why it is useful to choose handgrip strength to characterize the effect of physical strength.

Recognising the physical strength of men is very important to both women and men. According to the immunocompetence handicap hypothesis, testosterone decreases susceptibleness to diseases and parasites (Folstad & Karter, 1992). This makes testosterone an important factor that indicates the quality of a man's genetic make-up. Fink et al. (2005) quantified this using the testosterone value and emphasized that mate choice was influenced by testosterone production along with facial features. According to Sell et al. (2008), women are able to consistently perceive actual physical strength from the facial features of men. This strength is not only a crucial factor in women's pursuit of the ideal mate but also helps explain intrasexual competition among men (Sell et al., 2012). According to Puts (2010), physical strength and high masculinity are also positively associated with fighting ability and male-male competition in the evolutionary history of males. Additionally, a high testosterone level, which is a reason for having strong male characterized facial features, have been associated with anti-social behaviour in men as well (Dabbs et al., 1991). Which means that women do not have to recognise the actual physical strength of men only to enhance reproductive success, but also to understand who might be dangerous to them.

1.2 Perception of Attractiveness

Humans find certain features attractive, a perception that probably arose by the psychological adaptations typical for our species (Thornhill & Gangestad, 1999). Like any other species, humans also tend to adopt several strategies to benefit from finding the right mate at the right moment. Men tend to choose younger partners because reproductive capability is shorter in females than in males (Buss, 2002). Physical features also mirror juvenility and health. According to Buss (2007), full lips, bright hair and clear skin are associated with youthfulness. Berry (1991) reported that more masculine or powerful female faces were perceived as less attractive than women with feminine facial features. These and other studies support the hypothesis that there are similarities in men's perception of women's attractiveness (e.g. Rhodes, 2006).

Women's perception of male attractiveness is much more complex than facial attractiveness of women to men. This is because as various factors influence perception by women, and because women and men also have different reproductive strategies. Concurrently, higher physical strength is associated with greater resource-holding potential (Parker, 1974). A more powerful man is able to gather more resources and is more successful in male-male competition and in protecting himself, his partner and their offspring than men with weaker and more feminine facial features. Moreover, the immunocompetence handicap hypothesis states that a high level of testosterone, and males with masculine and sexually dimorphic facial traits, demonstrate disease resistance (Hamilton & Zuk, 1982). Johnston et al. (2001) stated that men with extreme testosterone markers were considered, by women, "to save" in terms of "good genes" for their offspring. Nonetheless, those markers are also associated with being cold, dishonesty, unfriendly, etc. (Perrett et al., 1998).

Certain studies show that masculinity and physical strength are positively associated with perceived attractiveness (Fink et al., 2007; Neave et al., 2003; Sell at al., 2017) but others report that the correlation between attractiveness and higher physical strength can be positive or negative (Frederick & Haselton, 2007). Such differences are related to the complexity of women's preferences, which are conditioned by several factors such as being in a current relationship or being at high conception risk.

Importantly, women's preferences in mate choice cannot be influenced solely by a higher testosterone level in men. There might be other factors which can affect the judgement of women's perception about male facial attractiveness. As maintained by the strategic pluralism theory (Gangestad & Simpsons, 2000), male reproductive strategies have evolved dictated by their value on the mating market. Women evaluate men with stronger facial features as less willing to be in a long-term relationship (Boothroyd et al., 2008). Additionally, stronger men tend not to invest enough care and resources in their offspring (Sell et al., 2017; Thornhill & Gangestad, 1999). Finally, Perrett et al. (1998) reported that females perceive the faces of highly masculine men as cold and less trustworthy than men with feminine facial features. High testosterone level and, by implication, high masculinity have been characterized with anti-social behaviour in men (Dabbs et al., 1991).

In view of the above considerations, the inverted-U hypothesis of masculine traits by Frederick & Haselton (2007) found that women preferred strong but not extremely strong men because of the perceived possibilities of the latter giving less care and having relationships with multiple females. Moreover, females generally do not choose weak men due to the

importance of reproductive success. Perrett et al. (1998) determined that the masculinity of male face shape was considered as a negative personal characteristic. Masculinity and its accompanying social perception, for example, depended on the testosterone level because a high testosterone level is associated with violence and divorce.

1.2.1 Differences between Perceptions of Attractiveness in Cultures

Women's perception of male facial attractiveness also depends on cultural and ethnic factors because different cultures have evolved in different kinds of ecological and anthropological environments. For example, Penton-Voak et al. (2004) compared British and Jamaican samples and reported that Jamaican women preferred more masculinized faces of men more attractive than British women did. They explain this result due to less medical care, a higher parasite load and less parental investment by Jamaican men in their offspring. Other studies also showed that women in environments with poor healthcare and higher pathogen levels showed greater preference for more masculine traits than shown by women in environments with better healthcare and lower pathogen levels (Thornhill & Gangestad, 1999). The reason for this tendency is women's conation to provide healthier genes to their offspring in environments with a poor healthcare system.

In this case, access to resources plays an essential role. Importantly, women in environments with lower resource potential may choose men who would invest more in their offspring and show a greater predilection for amassing enough resources – as opposed to men who might offer higher mate value and reproductive health but would not invest enough in their offspring (Little et al., 2011).

According to the meta-analysis by Langlois et al. (2000), there is strong agreement between different cultures about the attractiveness perception. This cross-cultural agreement can be explained by the standards of universal attractiveness (Fink & Neave, 2005). Certain traits might be attractive for women and men irrespective of where those raters come from or currently live.

Being familiar with facial characteristics is also important when it comes to perception by different cultures in different environments. This might influence people's characteristics and perceptions. Rhodes et al. (2005) showed that, in general, mixed European and Japanese facial features were found most attractive. European participants perceive the facial features

of their own population as much more attractive than composite faces. Zebrowitz et al. (1993) demonstrated that people tend to agree much more on what is more attractive when it comes to faces in their own population in relation to the faces with features non-common in their societies. In contrast, Scottish morphs were more appealing to White Scottish and Black South African participants than African morphs (Coetzee et al., 2014). In general, the results can be explained mainly by familiarity. More specifically, the South African population is more familiar with white people than the Scottish population is with Africans (Coetzee et al., 2014). Modernity reveals yet another facet of familiarity because the issue is not only about living in the same culture but also about how people become familiar with other societies and their certain traits through technology. Societies that have no or limited connection with people from other cultures might show a weaker tendency to find non-common facial or physical characteristics attractive (Thornhill & Gangestad, 1999). Swami and Tovée (2005) showed that urban Malaysians were much more in agreement with the British than with rural Malaysian people. This might be an important example of how judgement on attractiveness has changed over time due to modernization and media influences.

Of course, many other factors (including different personal preferences) may influence women's perception of men's attractiveness, calling for more detailed studies.

1.2.2 Effect of Reproductive and Relationship Status on Perception of Attractiveness

The menstrual cycle of women is thought to considerably influence women's perception of male attractiveness owing to multiple hormonal changes. For example, women are much more sensitive to stimuli during their reproductive phase of the menstrual cycle than in any other phase (Macrae et al., 2002; Barris et al., 1980).

Many studies (e.g. Penton- Voak et al., 1999) showed that women apparently prefer masculine and stronger male facial characteristics during the follicular phase of the menstrual cycle than in any other phase. The attention of women to testosterone-linked traits is related to their estrogen/progesterone ratio (Johnston et al., 2001). Women show a greater predilection for extra-pair mates during the follicular phase than the luteal phase (Gangestad et al., 2002).

The reason for such shifts in mate preferences by women at high conception risk is that they must maximize the possibility of conception during this period of their cycle.

Moreover, women may prefer men with stronger facial characteristics (with greater genetic fitness potential) than weaker men (with higher parental potential). One reason for this is that women have a greater possibility of becoming pregnant during this period and they might expect to have a healthy offspring owing to the father's healthier potential (Penton-Voak & Perrett, 2000). Accordingly, extra-pair sex can be useful and effective, but only during the follicular phase, because during the luteal phase women would receive no benefit from extra-pair sex (Thornhill & Gangestand, 1999).

Many factors potentially influence human perception of the attractiveness of the opposite sex. One example is the preference for a long- or short-term relationship. This choice plays a role in the mating strategies of women.

According to Buss and Schmitt (1993), women generally prefer long-term mating over short-term relationships. Like all other behaviours or preferences of humans, this choice is complex and associated with frequently changeable effects and factors. For example, women are inclined to choose more masculine men for short-term relationships than who they would prefer for long-term relationships (Waynforth et al., 2005). For a short-term relationship, women focus on the benefits of genetic fitness and higher mate quality, but for a long-term relationship, parental investment plays a much more important role.

This preference is also associated with the relationship status of women. Little et al. (2002) showed that women at high conception risk perceived men with male-like traits as being much more attractive if they have a partner. The reason for that women in a relationship already have a partner for a long-term relationship; therefore, focusing on the possibility of parental investment is not necessary. On the other hand, a woman without any partner gives preference to less masculine men who would potentially be a better parent to the offspring and make a higher investment than the usual masculine men. Due to the aforementioned reason, men with masculine and strong characterized facial features were evaluated by women as less willing to be in a long-term relationships (Boothroyd et al., 2008) or willing to be with multiple partners (Frederick & Haselton, 2007), which can reduce the chance of getting parental investment.

1.3 Hypotheses

If male physical strength provides an honest signals to women to choose their mates on the basis of their facial features, then it could be hypothesized that women recognise the actual physical strength of men using their facial traits as reference. For women rating male faces, it is hypothesized that the average morph is most attractive. This is because the average morph bears the promise of good parenting but also does not represent an extremely low level of testosterone. The hypothesis here is that there will be no differences between the Austrian and Turkish women's perceptions because both groups are familiar with the middle European facial features. Another hypothesis is that women who are currently in a relationship and in the phase with high conception risk will judge the stronger morph more attractive, unlike those who are single and at lower risk of conception. This is because highly fertile women in relationships tend to find stronger men more attractive than average or weaker men.

2. Material and Methods

2.1 Participants

In the present study, 213 female students at several universities in Istanbul and Vienna were asked during February and March 2019 to evaluate five morphed male faces. The test group of the study were 104 Austrian (mean age = 21.65 years, *SD* = 2.45 years) and 109 Turkish (mean age = 20.36 years, *SD* = 1.85 years) women students between 18 and 30 years of age.

Both parents of 56.7% of the Austrian participants hailed from Austria, whereas either the fathers or mothers of only 10.6% of participants were from Austria. Families of 16.3% of the participants were from Eastern Europe, and those of 7.7% of students were from Germany. The rest of the participants had mixed European cultures. The parents of one student were from Iran.

Both parents of 83.5% of Turkish participants were from Turkey and either the fathers or mothers of 5.5 % of the participants hailed from Turkey. Families of 5.5% of participants were from Eastern Europe, and families of 1.8% of participants were from Kazakhstan and Turkmenistan each. Two participants' parents were of mixed-cultures from Europe.

Of the Austrian participants, 26.2% were from the department of teacher education other larger affiliations were as follows: 12.6%from the department of architecture, 9.7% department of history, 8.7% philology, and 7.8% psychology. The remainder were from several departments such as zoology, political science and sociology.

Of the Turkish participants, 16.5% were students at the department of philology, 16.5% at the department of physiology. The larger affiliation were 13.8% each from the geography and the dialysis departments participated, 6.4%from the department of sociology and from the department of information and document management, and 5.5% from the department of the history of science. The remaining students were from several departments including philosophy, history and anthropology.

2.2 Facial Morphs

Five facial morphs of man were provided by Prof. Katrin Schaefer and Dr. Sonja Windhager and evaluated by the test group. For these, 26 frontal photographs of men aged between 18 and 31 years with the mean age of 24 years (average handgrip strength of 50.38 kgf) were taken with a neutral expression and were formatted to an average morph. The physical strength of the morphs used in the present study was based on input by German students and measured with a dynamometer using handgrip strength values (Windhager et al., 2011). The average morph was subsequently altered through shape regression (using the geometric morphometric toolkit Windhager et al. (2011)) at two and four deviations of handgrip strength from the sample average. One standard deviation amounted to 7.99 kgf. The morphs had different modelled handgrip strengths at 18.44 kgf, −4SD; 34.41 kgf, −2SD; 50.38 kgf, Average-Morph; 66.36 kgf, +2SD and 82.33 kgf, +4SD (Figure 1). They were created in tpsSuper 2.04 subsequent to the target estimation in tpsRegr 1.45 (Rohlf, 2015).

MORPHS					HGS
−4 SD HGS from the mean (kgf)	−2 SD HGS from the mean (kgf)	Average HGS (kgf)	+2 SD HGS from the mean (kgf)	+4 SD HGS from the mean (kgf)	1 SD HGS (kgf)
18.44	34.41	50.38	66.36	82.33	7.99

Figure 1: The five morphs with associated handgrip value in kilogram-force (Prucha 2018). 26 frontal pictures of men with ages ranging between 18 and 31 years (mean age: 24 years, average handgrip strength: 50.38 kgf) were formatted to an average morph. The other target configurations represent plus and minus 2 and 4 standard deviations of handgrip strength from that average. One standard deviation amounted to 7.99 kgf.

2.3 Data Collection

Data was collected at several public and private universities in Istanbul and Vienna during February and March 2019. The evaluations took place inside buildings to minimize the risk of sun reflection on the computer screen. The study used an online questionnaire created on www.soscisurvey.de (Leiner, 2019). The questionnaire was in German for Austrian participants and in Turkish for Turkish participants.

Before filling out the questionnaire, the participants were briefly informed about the survey and the study with more or less the following greeting: "Hello, have you got enough time to participate in a study for my master thesis?"

If they agreed to participate and confirmed that their data could be used in statistical analysis, they were left alone with the computer. All were informed that they could seek clarification about any questions and that there were no right or wrong answers. The first page of the survey also contained detailed information about the study in the following sentences:

"Hello,

My name is Veronika Melis Köseoğlu and I am studying Anthropology at the University of Vienna. As part of my master thesis, I am carrying out a study to assess the characteristics of different young men. There is no time limit, but I ask you to rate the faces as spontaneously and intuitively as possible. There are no right or wrong answers.

At the end of the questionnaire, I ask you for a few details about yourself.

Thank you for your time and cooperation!''

For the Turkish participants, the original German text was translated by the author into her mother tongue. She also consulted several persons whose first languages were Turkish or German to ensure that the meaning of the original text remained the same.

In the following five pages of the survey, the participants could see all five male facial photographs in a random order, one at a time. They had to evaluate how appealing the photograph of a particular person was to them. The participants were asked to rate attractiveness, physical strength, dominance, masculinity, trustworthiness, aggressiveness and sympathy for each of the five photographs using a slide control. By moving the slider, the participants rated the morphs on a scale of 1 to 101 (i.e. 1 = less attractive or not physically strong and 101 = most attractive or physically strong). The participants could not see those numbers, as their natural perception was tested (Figure 2).

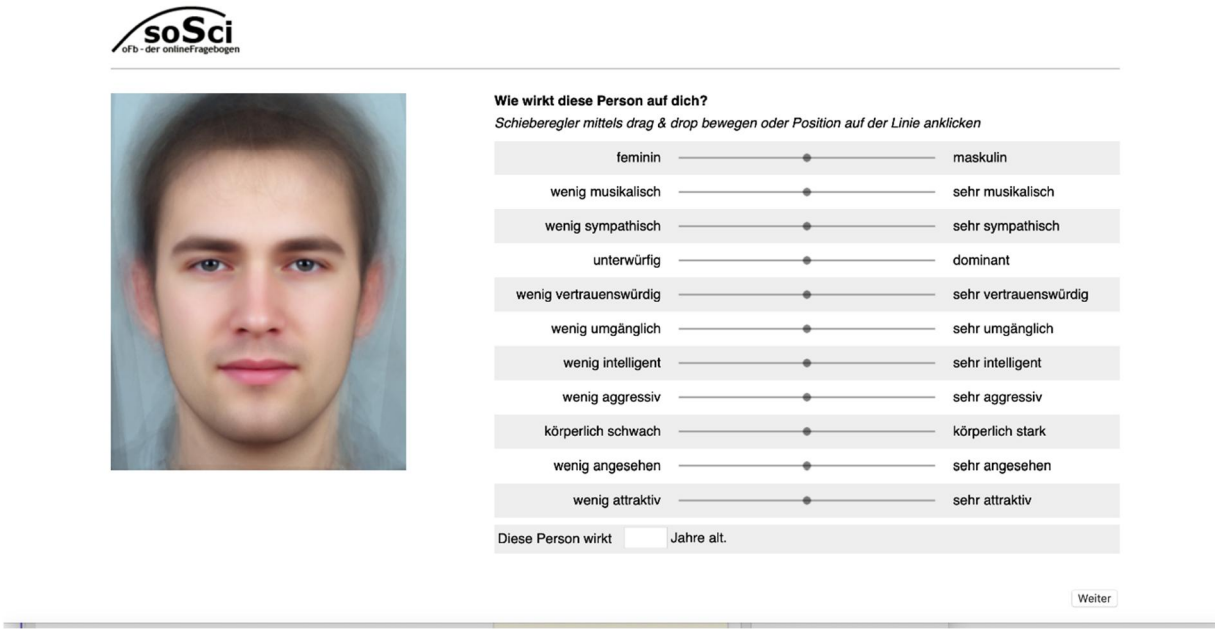

Figure 2: Sample page of the survey (German version) on which the Austrian participants rated the morphs. The participants saw a random morph on every page and evaluated it by dragging and dropping the slide control or clicking on the characteristics such as attractiveness, physical strength, etc. For Turkish participants, the survey was translated into Turkish.

After the rating test, the participants were asked further questions to assess their reproductive status:

- Are you pregnant?
- Do you use contraceptive pills to prevent pregnancy?
- On which exact date did you have your last menstruation?
- Is your menstruation regular?
- How long does your menstruation cycle usually take?

Additionally, in order to identify the relationship status of the women who rated the morphs, the following questions were asked:

- Are you currently in a relationship? If yes, how long have you been together with your partner?

On the following pages, participants were also asked about their age, nationality, educational level, frequency of exercise and socioeconomic status.

Finally, on the last page of the survey, the participant was presented with detailed information about the study and a field seeking informed consent. .If they clicked on the confirmation button, they agreed that their information and ratings could be used in the study.

2.4 Assessing the Reproductive Status of Women

After obtaining information about the participants' menstrual cycle, three different categories were constructed: (1) high conception risk group, (2) low conception risk group and (3) another group which did not give sufficient information about menstruation, was pregnant, used birth control pills, had no regular menstrual cycle, or the length of their menstrual cycle was longer or shorter than natural average variation, i.e. shorter than 19 days or longer than 37 days. The latter group was not included in the statistical analysis because there was no certainty about their reproductive status.

The present study applied the backward-counting method to estimate the date of ovulation (Dixon, 1980). The high conception risk was calculated by determining the first day of the last period, i.e., by estimating the first day of the following menstruation and the mean of length of the menstruation minus 14 days. This calculation enables estimating the day of ovulation for every woman. The subsequent four days were considered as high conception risk because those days found a higher probability of pregnancy days (Mikolajczyk & Stanford, 2005). Accordingly, the date of ovulation and the following three days were regarded as high conception risk phase (Figure 3).

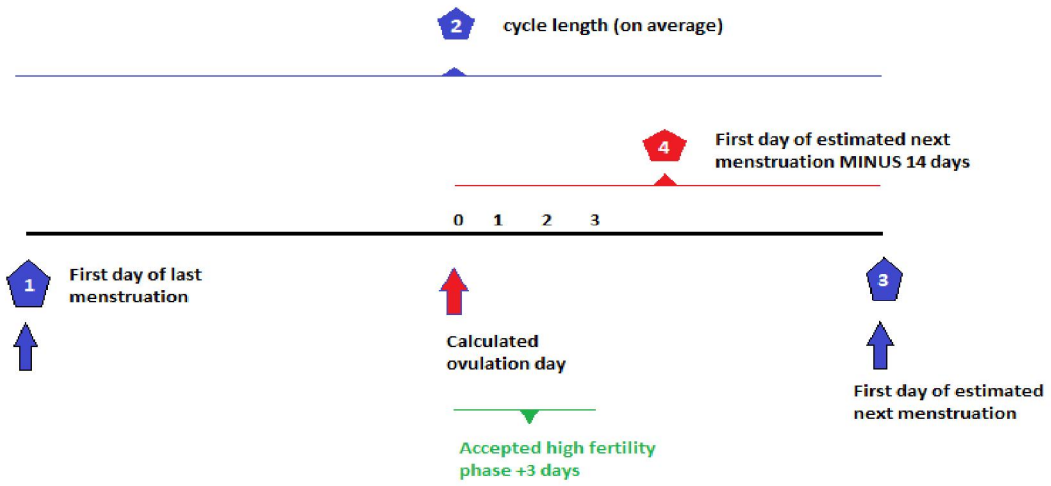

Figure 3: Calculation of the cycle phase. The first day of the last menstruation and the typical cycle length were provided by the participants. The first day of the following menstruation was calculated as a first step. In order to determine the ovulation day, 14 days were deducted from the first day of the estimated next menstruation. The estimated ovulation day and the following three days were considered as the high conception risk. Women participating in the survey during these four days were assumed to be at high conception risk.

2.5 Statistical Analysis

In a first step, a repeated-measures analysis of variance (ANOVA) test was conducted in order to determine the relation of actual handgrip strength (as reflected in a facial shape) to perceived strength and attractiveness. The same test was performed to examine the effect of potential national differences in the relationship between actual physical/handgrip strength to perceived strength and attractiveness of morphs. In addition, the analyses of the differences relating to nationality, being at high conception risk and relationship status on perceived attractiveness were performed separately for Austrian and Turkish participants to examine potential differences between their perceptions. Statistical interactions were reported, which show the contrast of those perceptions. In addition, potential group differences were investigated as to the effect of reproductive and relationship status as well as nationality. A post hoc test was applied to identify if there were any pair-wise significant differences in women's perception between the morphs. The Bonferroni correction was used to determine which morphs were evaluated significantly differently by participants than other morphs. Statistical significance was assumed at $p \leq 0.05$. All statistical analyses were performed with IBM SPSS Statistics 25.

According to Field (2013), if the Mauchly Test of Sphericity is not significant in the repeated measures ANOVA test, the Sphericity Assumed line in the SPSS output must be reported. In contrast, if the Mauchly Test of Sphericity is significant, then the value of the Epsilon Greenhouse-Geisser's plays a role. If the Epsilon Greenhouse-Geisser's on the Mauchly Test of Sphericity table is larger than 0.75, then the Huynh-Feldt value must be reported, if less than 0.75, then the value of Greenhouse- Geisser's must be taken into account. The effect size was defined with the help of partial eta squared in repeated measures ANOVA test output, in which 0.01 was defined as small effect size, 0.06 as medium and 0.14 as large effect size (Cohen, 1998; Richardson, 2011). The graphs showing the calculated date of ovulation and the following three days with participants making a judgement on the attractiveness of every morph was created separately for Austrian and Turkish participants using IBM SPSS Statistics 25.

3. Results

3.1 Descriptive Statistics

The participants who evaluated the five male morphs in this study were Austrian (N=104, mean age=21.65 years, SD=2.45 years) and Turkish (N=109, mean age=20.36 years, SD=1.85 years) female university students aged between 18 and 30 years. For 79 of the 104 Austrian participants, the exact ovulation day could not be calculated and these women were excluded in the tests for the effect of reproductive status. Of the remaining 25 participants (mean age=21.72 years, SD=2.46 years), six women were at high conception risk and 19 were at low conception risk. Of the 109 Turkish participants, the reproductive status for 56 women (mean age=20.57 years, SD=2.16 years) could be estimated. Eight of these participants were at high conception risk and 48 at low conception risk. Within the Austrian group (N=102, mean age=21.68 years, SD=2.46 years), two participants had to be excluded for the test of the effect of relationship status because their relationship status was uncertain. According to the survey, 43 Austrian participants were identified as partnered women and 59 as single. For the Turkish participants (N=103, mean age=20.45 years, SD=1.87 years), 43 were in a partnership and 60 were single, but six participants did not mention their relationship status and, as a result, the effect of the status on their perception of attractiveness could not be included in the test.

3.2 Perception of Physical Strength

Actual handgrip strength was significantly related to perceived strength (*Huynh-Feldt* F=34.690, p<0.001, partial η2=0.141). According to the definition by Cohen (1988), this result of partial eta squared is a large effect size. As for perceived strength, linear (F=56.990, p<0.001, partial η2=0.212) and quadratic (F=38.817, p<0.001, partial η2=0.155) models were significant, and both results showed a large effect size as well.

The −4SD and −2SD morphs were judged as significantly weaker (Post hoc tests with Bonferroni correction, p≤0.048) than the other morphs. Furthermore, the −4SD morph was perceived as being significantly weaker (p<0.001) than any other morph. In the view of participants, the average morph was considered marginally stronger than the −2SD and −4SD morphs (p<0.001) (Figure 4).

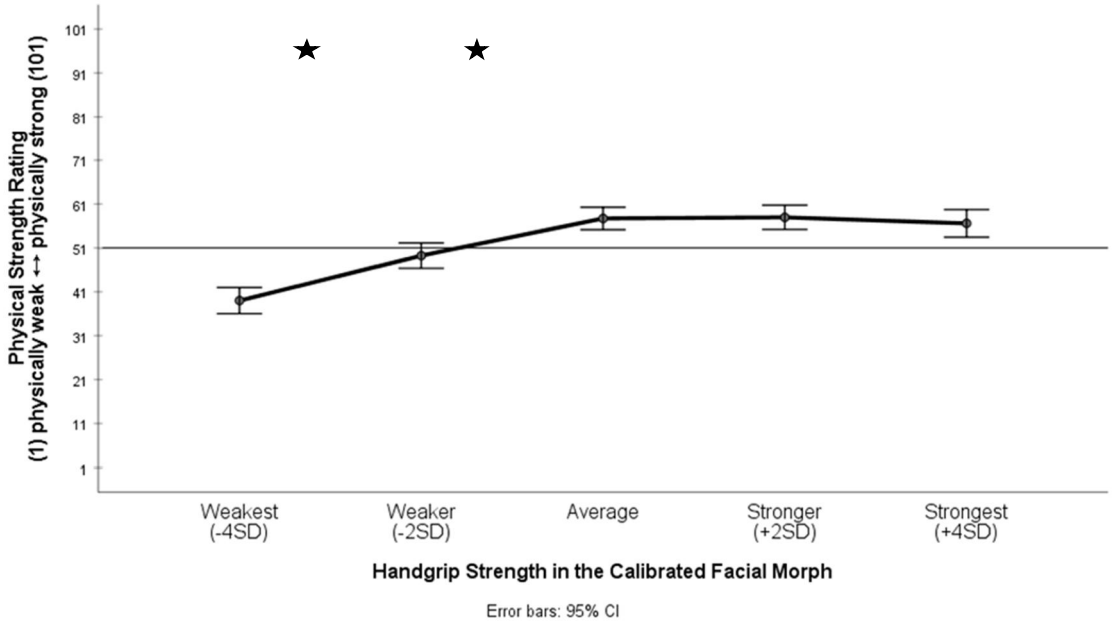

Figure 4: Participants' rating for perceived physical strength in relation to actual physical strength. The handgrip strength is significantly related to the perceived strength (*Huynh-Feldt F*=34.690, $p<0.001$, part. partial η2= 0.141). For the perceived strength, linear (*F*=56.990, $p<0.001$, partial η2=0.212) and quadratic (*F*= 38.817, $p<0.001$, partial η2=0.155) models are significant. – 4SD and – 2SD morphs were evaluated by participants as considerably weaker than other morphs. Significant differences are marked with a star.

Actual handgrip strength is related to perceived strength in both groups (*Huynh-Feldt F*=34.543, $p<0.001$, partial η2= 0.141). For the perceived physical strength, linear (*F*=56.747, $p<0.001$, partial η2=0.212) and quadratic (*F*=39.061, $p<0.001$, partial η2=0.156) models were also significant. Both results show a large effect.

Additionally, no substantial interaction between populations and depicted the strength of the morph (*Huynh-Feldt F*=1.2119, $p=0.302$, partial η2=0.006). Concurrent tests of subject effects showed that Austrian and Turkish participants did not significantly differ with regard to the results (*F*= 0.206, $p= 0.651$, partial η2= 0.002) (Figure 5). The participants judged the −4SD and −2SD morphs significantly as weaker than other morphs (Bonferroni post hoc tests, $p<0.05$). Applying these tests to the effect of nationality showed no significant perception differences between Austrian and Turkish participants ($p=0.651$).

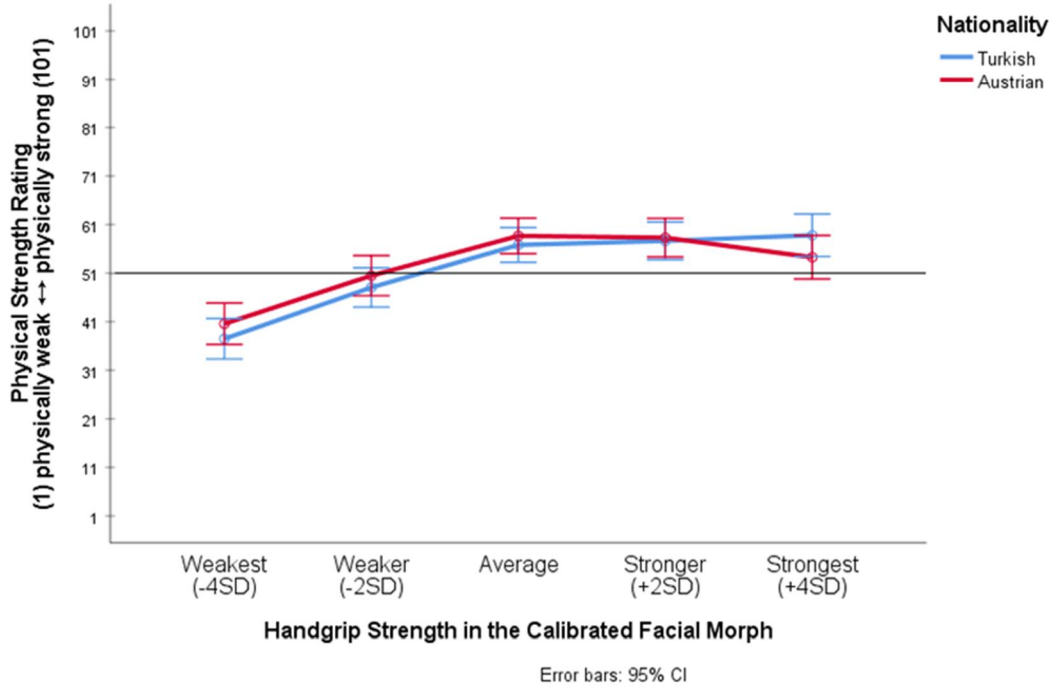

Figure 5: Austrian and Turkish participants' separate assessments of perceived physical strength with relation to actual physical strength. No statistically significant differences (F= 0.206, p= 0.651, partial η2= 0.002) and interactions (*Huynh-Feldt* F=1.2119, p=0.302, partial η2=0.006) were found between Austrian and Turkish participants' perceptions of physical strength. Significant differences are marked with a star.

3.3 Average Morph is Attractive

Actual handgrip strength significantly influenced the participants' perception of attractiveness (*Huynh-Feldt* F=59.759, p<0.001, partial η2= 0.220). For attractiveness perceptions, linear (F=11.779, p=0.001, partial η2=0.053) and quadratic (F= 220.688, p<0.001, partial η2=0.521) models were also significant. The quadratic model showed a large effect size, although the linear model yielded only a medium-sized effect.

The average morph was significantly more attractive to the participants (Post hoc tests with Bonferroni correction, p<0.001) than other morphs, except for the −2SD morph (p=0.215). There were no significant perception differences with respect to attractiveness between the morphs −4SD and +4SD (p= 0.70). Furthermore, the +4SD morph was significantly (p<0.001) less attractive than the other morphs, except for −4SD (p=0.070) (Figure 6).

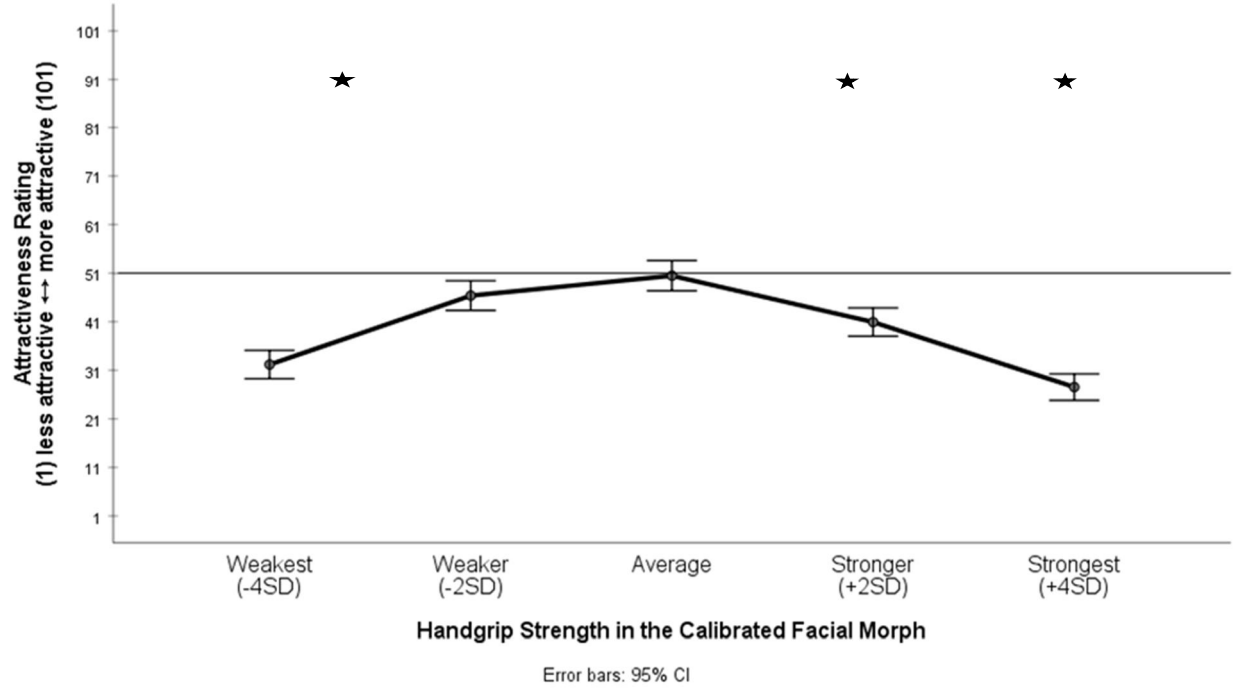

Figure 6: Participants' rating for the perceived attractiveness with relation to actual physical strength. The actual handgrip strength affects women's perception of male attractiveness significantly (*Huynh-Feldt* F=59.759, p<0.001, partial η2= 0.220. The quadratic (F= 220.688, p<0.001, partial η2=0.521) model is significant as well. The morphs were perceived as different then each other and the significant differences were highlighted with a star (*). The average morph was significantly (p<0.001) more attractive to the participants than the other morphs, except for the −2SD morph (p=0.215). The +4SD morph was significantly (p<0.001) less attractive than the other morphs, except for −4SD (p=0.70).

3.4 Differences and Similarities in Perception of Attractiveness between Austrian and Turkish Participants

Actual handgrip strength significantly affected the perceived physical strength of morphs (*Huynh-Feldt* F=59.675, p<0.001, partial η2= 0.220). The quadratic model yielded the greatest effect size: attractiveness and actual physical strength as reflected in the face were presented in the form of an inverted U-shape (*Huynh-Feldt* F= 230.337 p<0.001, partial η2= 0.522). There was no significant interaction effect on perceived attractiveness between Austrian and Turkish participants (*Huynh-Feldt* F=0.713, p= 0.577, partial η2=0.003). Nonetheless, their perceptions were significantly different (F=8.880, p=0.003, partial η2= 0.04). The value 0.04 represents a small-to-medium-sized effect (Figure 7).

The participants determined that the average morph was significantly more attractive (Post hoc tests with Bonferroni correction, p<0.001) than the other morphs, except for the −2SD morph (p=0.219). There were no significant differences between morphs −4SD and +4

SD (p=0.075), or between − 2SD and +2SD (p=0.053). −4SD and +4SD morphs, which shared equal attractiveness between each other, were significantly (p<0.001) less attractive than other morphs (Table 1). Post hoc tests for the main effect of nationality showed that Austrian participants gave significantly higher ratings to all morphs than those given by Turkish participants (p=0.003).

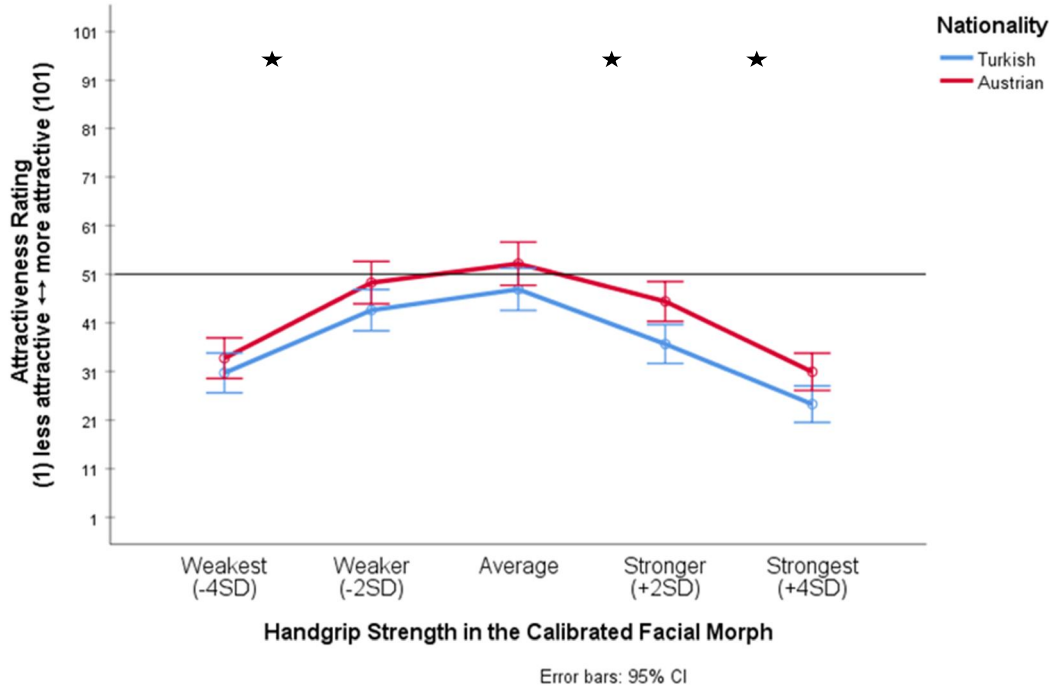

Figure 7: Austrian and Turkish participants' separate assessments of perceived attractiveness with relation to actual physical strength. No interaction was found between the Austrian and Turkish participants' perception of attractiveness *Huynh-Feldt* (F=0.713, p= 0.577, partial η2=0.003). Nonetheless, the values themselves were significantly different (F=8.880, p=0.003, partial η2= 0.04). The differences (marked with *) between − 4SD and − 2SD, average and +2SD as well as +2SD and +4SD, are statistically significant. No significant differences were found between +4SD and − 4SD or between − 2SD and +2SD.

Table 1: The result of post hoc tests with Bonferroni correction. The morphs marked with * and written italic differ significantly from other morphs. The average morph was significantly more attractive to the participants than −4SD, +2SD and +4SD, except for the −2SD morph (p=0.215). There are no significant perception differences with respect to attractiveness for morphs −4SD and +4SD (p= 0.70). Furthermore, the +4SD morph was significantly (p<0.001) less attractive than other morphs.

	-4SD	-2SD	Avg.	+2SD	+4SD
-4SD	-	*-14.224**	*-18.313**	*-8.809**	4.650
-2SD	*14.224**	-	-4.089	5.414	*18.829**
Avg.	*18.313**	4.089	-	*9.504**	*22.918**
2SD	*8.809**	-5.414	*-9.504**	-	*13.414**
4SD	-4.605	*-18.829**	*-22.918**	-13.414	-

Handgrip strength significantly influenced the Austrian participants' perception of attractiveness (*Huynh-Feldt* F=39.529, p<0.001, partial η2=0.277). Partial eta squared showed a large-sized effect. For the Austrian participants' perception of attractiveness, the quadratic (F= 161.773, p<0.001, partial η2=0.611) model was also significant and presented the face in the form of an inverted U-shape. The partial eta squared indicated a large-sized effect for the quadratic model.

Austrian participants rated the average morph as significantly (Bonferroni post hoc test p≤0.001) more attractive than other morphs, except for −2SD (p=0.619). However, the −4SD and +4SD morphs, sharing equal attractiveness between each other (p=1.000), are significantly (p<0.001) less attractive to participants than other morphs (Figure 8).

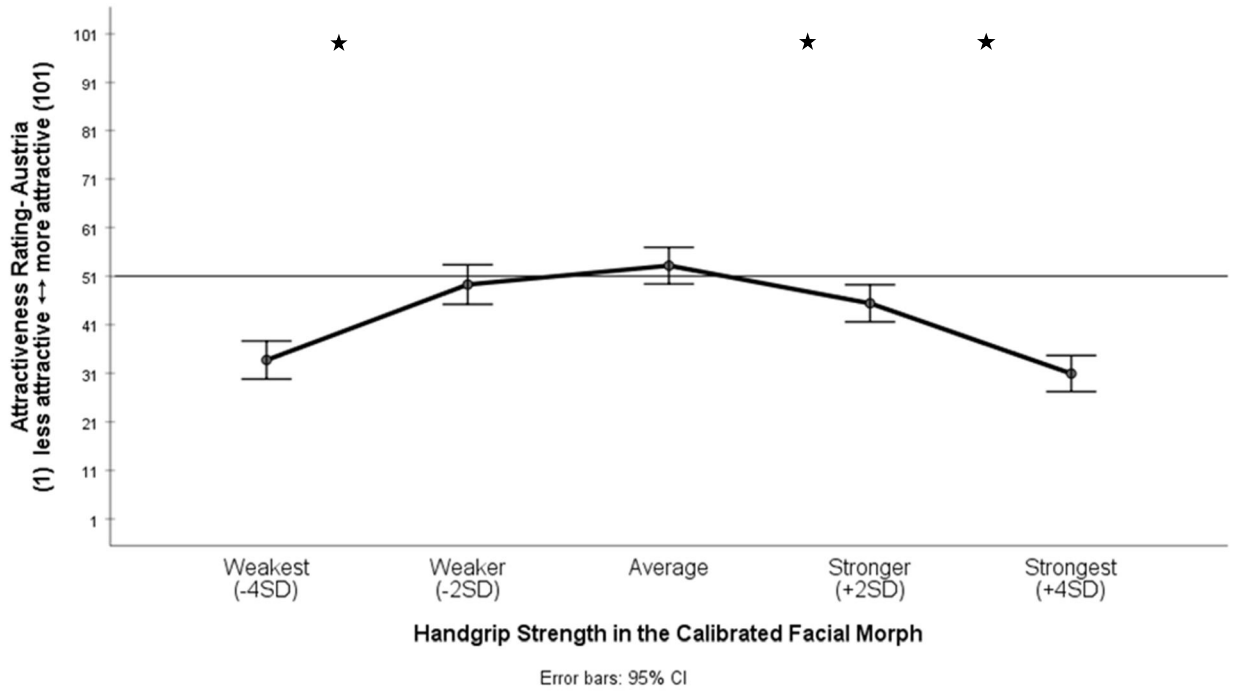

Figure 8: Austrian participants' rating on attractiveness in relation to actual physical strength. The actual handgrip strength significantly affects the participants' perception of attractiveness (*Huynh-Feldt F*=39.529, $p<0.001$, partial $\eta 2=0.277$). The differences in Austrian perceptions of attractiveness for −4SD and −2SD, average and +2SD, as well as +2SD and +4SD morphs are significant. Significant differences are marked with a star (*). The morphs +4SD and −4SD, as well as −2SD and +2SD, were not significantly different.

Handgrip strength of morphs was significantly influential on the Turkish participants' perception of attractiveness (*Huynh-Feldt F*=24.666, $p<0.001$, partial $\eta 2=0.186$. Partial eta squared revealed a large-sized effect, as in the case of Austrian participants. For the Turkish participants, the linear (*F*=9.760, $p=0.02$, partial $\eta 2=0.083$) and quadratic (*F*= 87.840, $p<0.001$, partial $\eta 2=0.449$) models also yielded significant results (medium-sized for the linear model, large-sized effect for the quadratic model).

The −4SD morph was evaluated by Turkish participants as less attractive than −2SD (post hoc test with Bonferroni correction, $p<0.001$) and then average morphs ($p<0.001$). The average morph was significantly more attractive to the Turkish participants than −4SD ($p<0.001$), +2SD ($p=0.003$) and +4SD ($p<0.001$). Moreover, the +4SD morph is significantly ($p<0.001$) less attractive than other morphs except for −4SD ($p= 0.118$) (Figure 9).

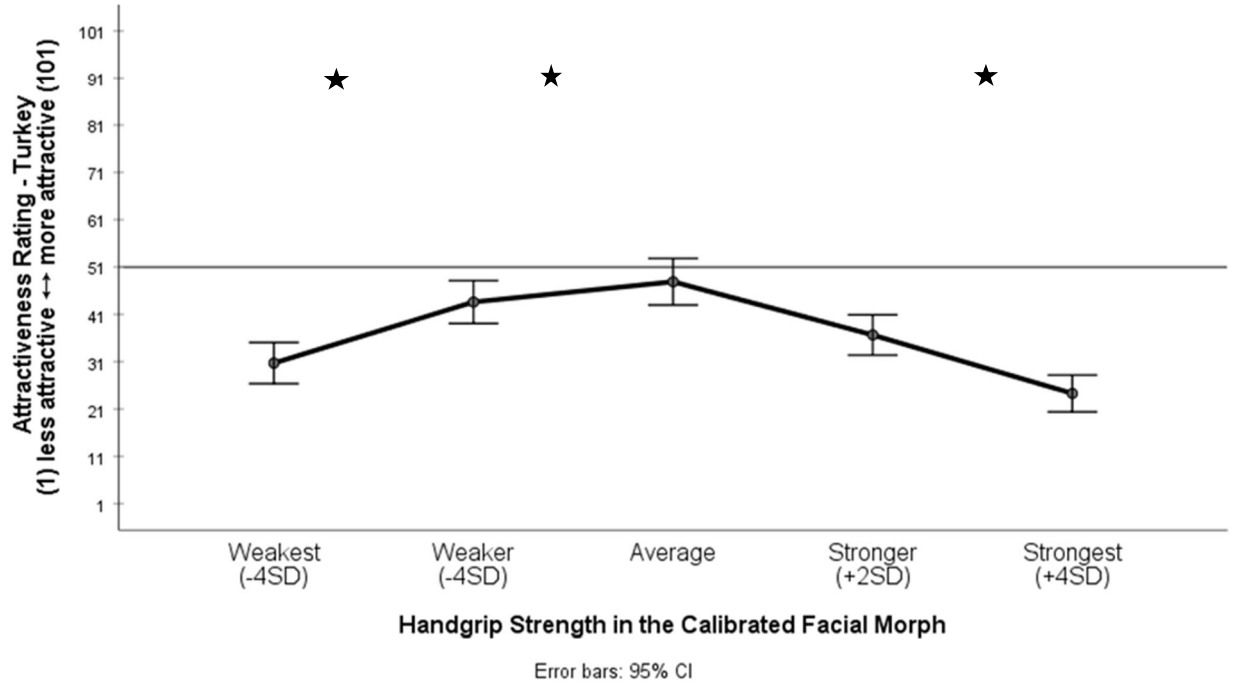

Figure 9: Turkish participants' rating on attractiveness in relation to actual physical strength. Handgrip strength significantly affects the Turkish participants' perception of male attractiveness (*Huynh-Feldt F*=24.666 $p<0.001$, partial η2=0.186). Linear (*F*=9.760, $p=0.02$, partial η2=0.083) and quadratic (*F*= 87.840, $p<0.001$, partial η2=0.449) models are significant. The differences between perceptions of attractiveness in −4SD and −2SD, −2SD and average as well as +2SD and +4SD morphs, which are marked with a star, are significant. No significant differences were found between morphs +4SD and −4SD, − 4SD and +2SD, −2SD and average, as well as −2SD and +2SD.

3.5 Non-significant Effect of Calculated Ovulation on the Perception of Austrian and Turkish participants

To determine potential perception differences between Austrian and Turkish participants, the repeated-measures ANOVA test was performed separately for both groups.

The exact ovulation day for 79 out of 104 Austrian participants could not be determined. Of the remaining 25 participants, 6 were at high conception risk and 19 in low conception risk group.

Actual handgrip strength significantly influenced the perception of attractiveness in those participants whose ovulation day could be calculated (*Sphericity Assumed F*= 6.678, $p<0.001$, partial η2=0.225). Partial eta squared (0.225) indicated a large-sized effect. The quadratic model (*F*= 23.431, $p<0.001$, partial η2=0.505) also yielded a significant result, which is a medium-sized effect. The repeated-ANOVA test indicated no interaction effect

between high- and low- conception risk groups of Austrian participants with regard to perception of attractiveness (*Sphericity Assumed* F=0.601, p=0.663, partial η2=0.025). The high- and low-conception groups of the participants did not differ (F=0.718, p=0.405, partial η2=0.030) (Figure 10).

In participants whose reproductive status could be ascertained, only the stronger morph was evaluated as being significantly less attractive (Bonferroni post hoc test, p<0.05) than other morphs, except for –4SD. The participants at high conception risk found all the morphs more attractive, but the result was not statistically significant (p=0.405). Interestingly, no single Austrian participant at high conception risk evaluated the +2SD or +4SD morphs as generally more attractive in relation to what participants at low conception risk would do (Figures 11-15).

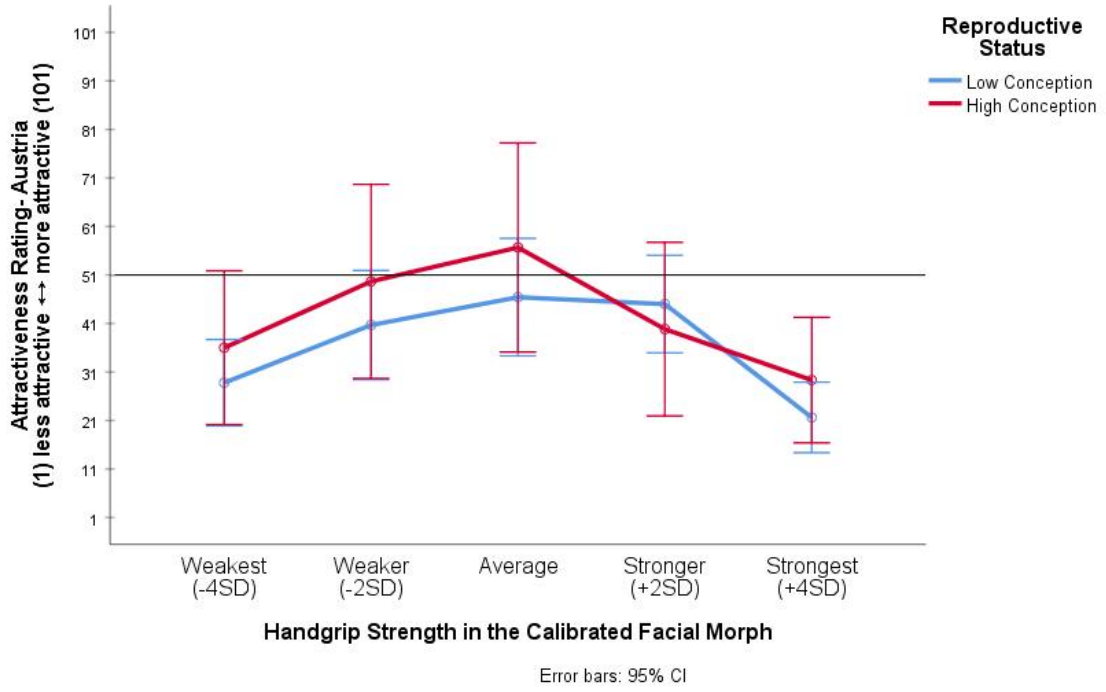

Figure 10: Austrian participants' rating on attractiveness with relation to the actual physical strength with different lines of reproductive status. Between the participants in higher (N=6) and lower (N=19) conceptions risk days, no significant differences (F=0.718, p=0.405, partial η2=0.030) or interactions (*Sphericity Assumed* F=0.601, p=0.663, partial η2 0.025) were found.

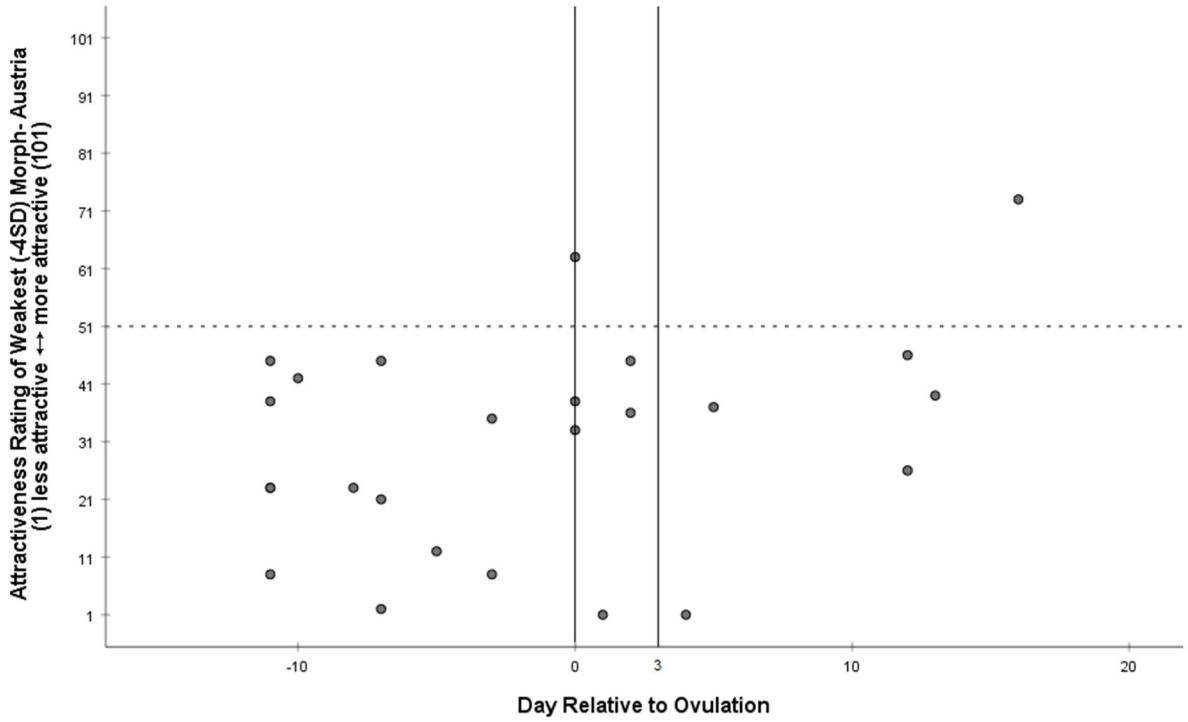

Figure 11: Austrian participants' rating on the attractiveness of the −4SD morph in relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conceptions risk. No extreme differences in perceptions were recorded between high- or low-conception risk groups.

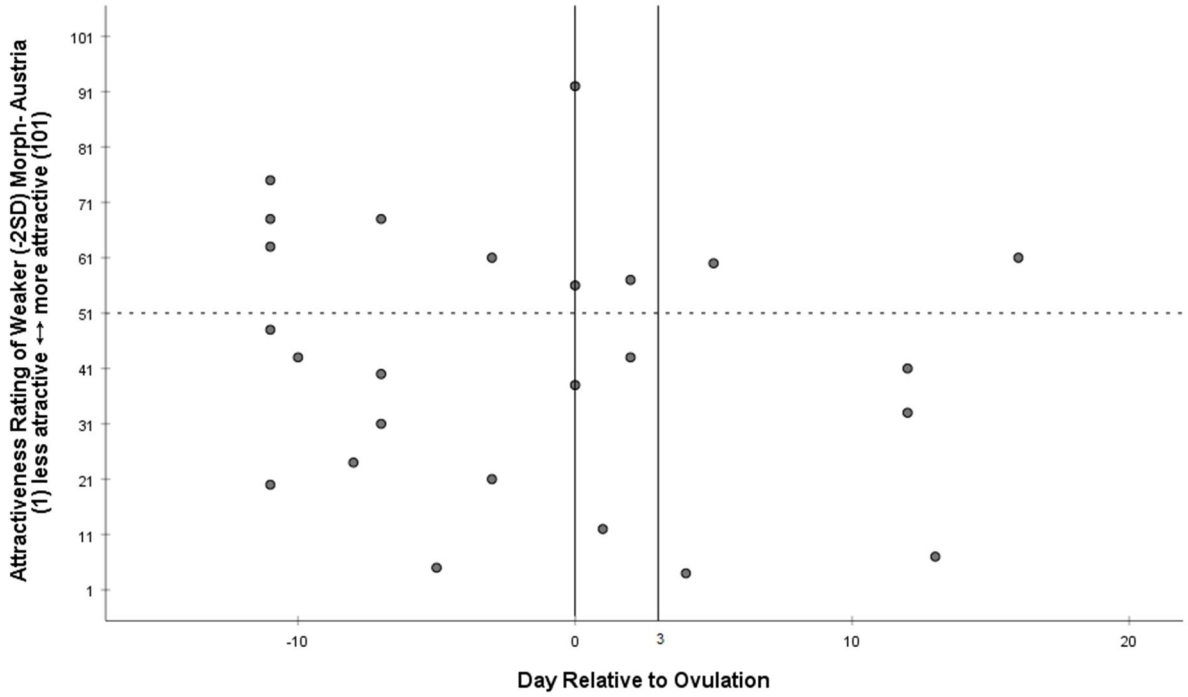

Figure 12: Austrian participants' rating on the attractiveness of the −2SD morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. Only one participant at high conception risk perceived the −2SD morph as highly attractive.

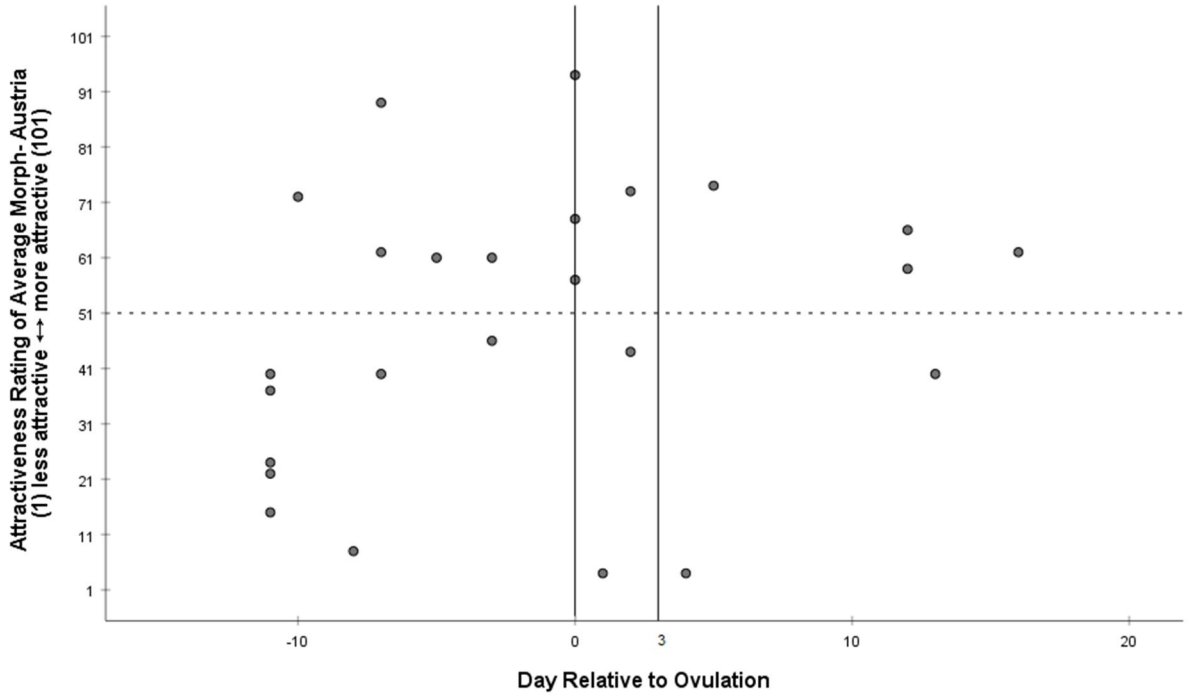

Figure 13: Austrian participants' rating on the attractiveness of the average morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. There are no significant differences in perceptions by participants at high- or low- conception risk.

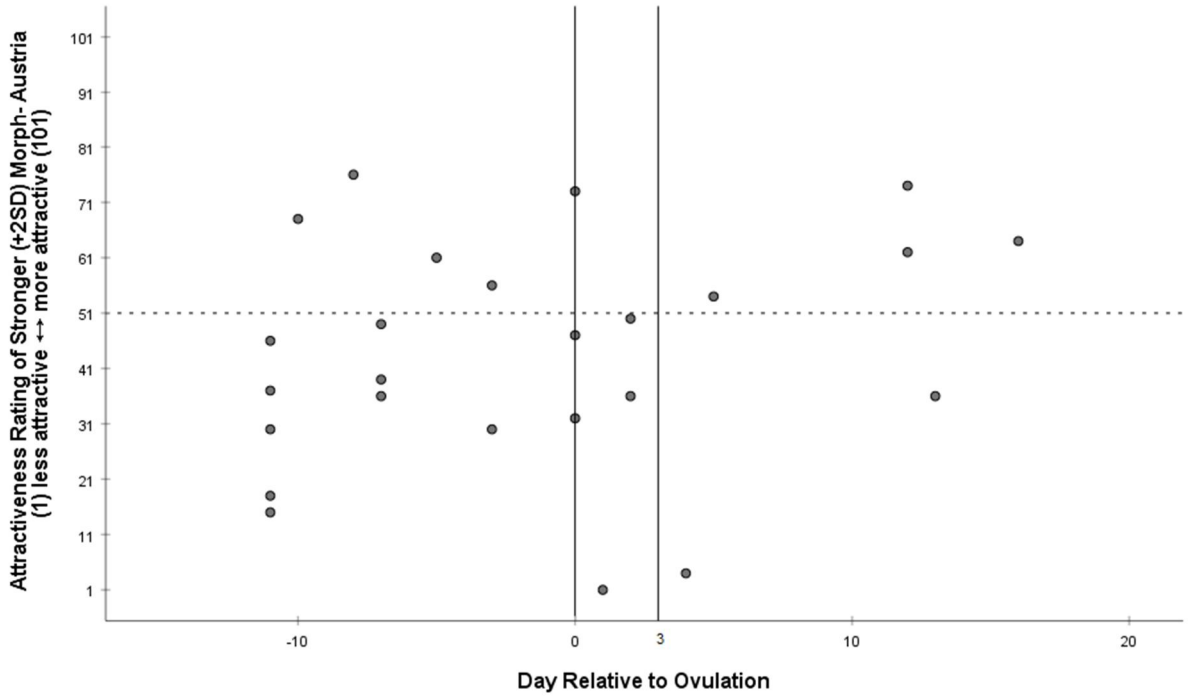

Figure 14: Austrian participants' rating on the attractiveness of the +2SD morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. Out of six, only one participant was in the ovulation period, and eight others were not at high conception risk, perceived the stronger morph as highly attractive.

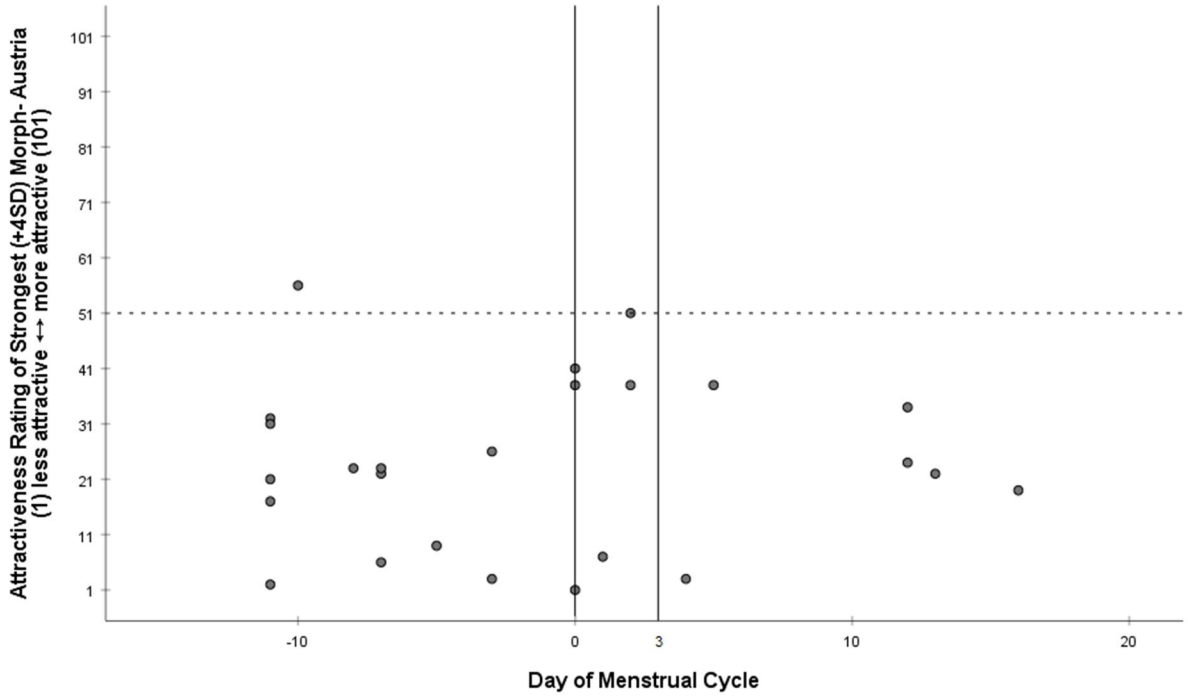

Figure 15: Austrian participants' rating on the attractiveness of the +4SD morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. No significant differences in perceptions were recorded for high- or low-conception risk groups.

Forty-eight of the Turkish participants were at low conception risk and eight were at high conception risk (the exact ovulation day of the others could not be determined).

Handgrip strength significantly influenced the perception of attractiveness by Turkish participants whose ovulation day could be calculated (*Huynh-Feldt F*= 7.300, $p<0.001$, partial $\eta 2=0.119$). The quadratic model yielded the greatest effect size (*Huynh-Feldt F*=28.692, $p<0.001$, partial $\eta 2= 0.347$).

There was no interaction between high and low conception risk groups in Turkish participants (*Huynh-Feldt F*=1.186, $p=0.318$, partial $\eta 2=0.021$) (Figure 16). Only the +4SD morph was perceived as being significantly less attractive ($p<0.05$) than other morphs, except for the −4SD morph. The post hoc test for the main effect of reproductive status indicated that, on average, the Turkish participants at high conception risk actually rated the morphs more attractive, but the results were not statistically significant ($p=0.184$). Accordingly, only one Turkish woman at high conception risk rated the strongest morph highly attractive (Figures 17-21).

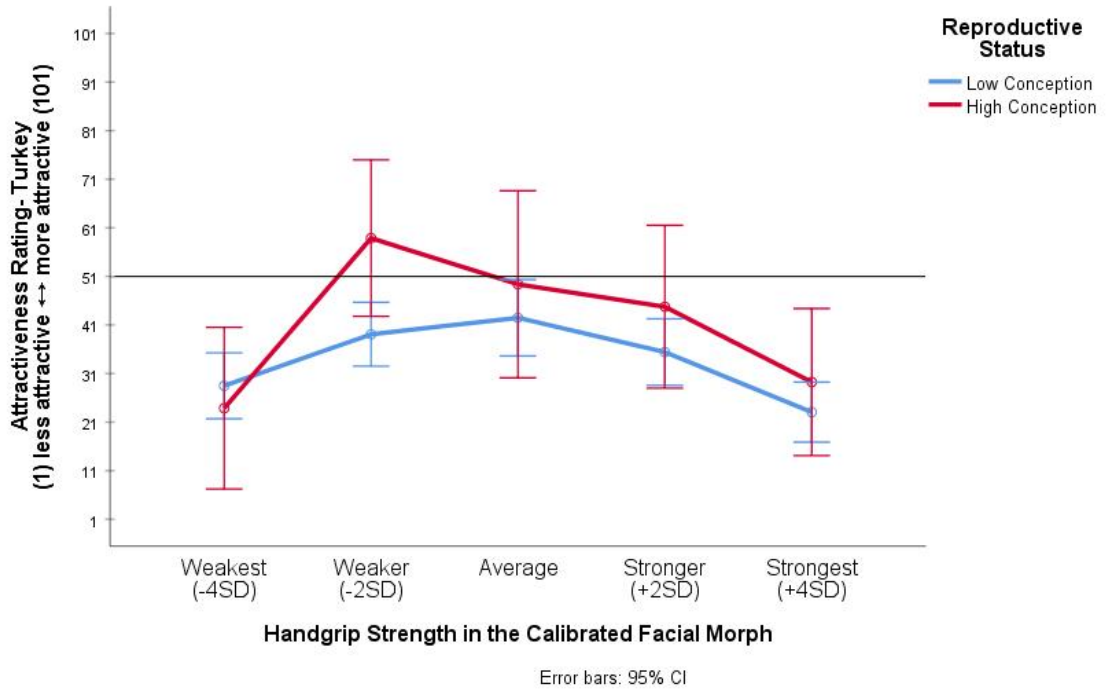

Figure 16: Turkish participants' rating on the attractiveness of morphs with relation to the actual physical strength with different curves of reproductive status. There are no significant differences (F=1.815, p=0.184, partial η2=0.033) or interactions (*Huynh-Feldt* F=1.186, p=0.318, partial η2=0.021) between Turkish participants at low- and high-conception risk.

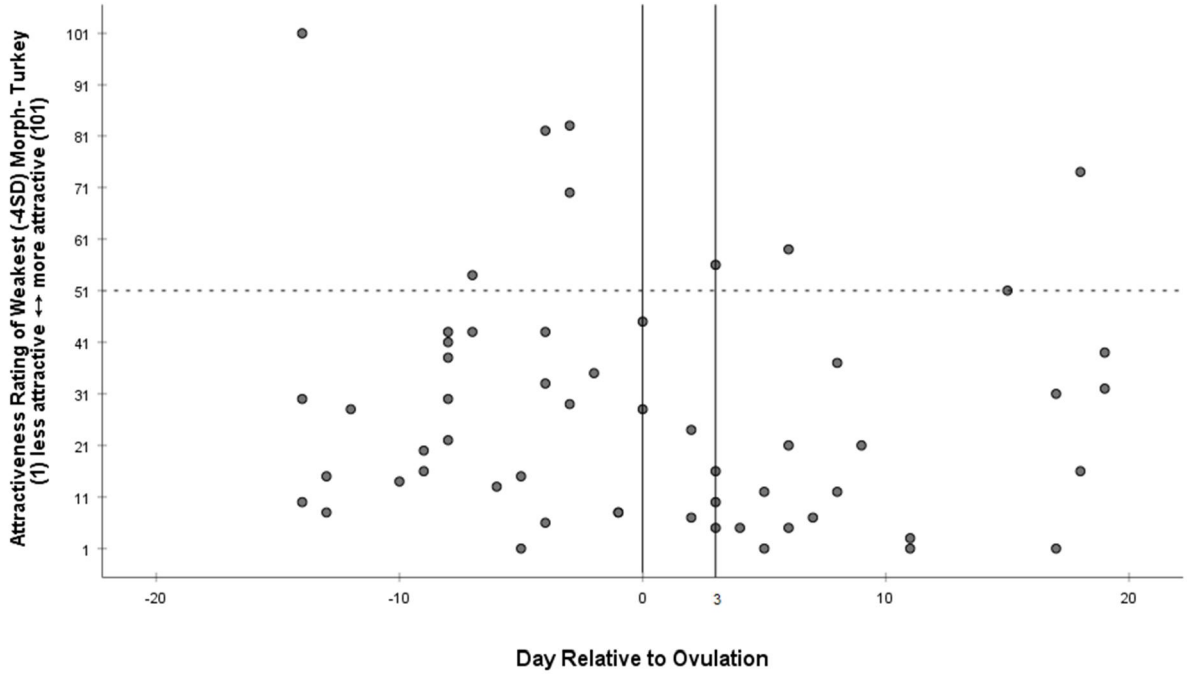

Figure 17: Turkish participants' rating on the attractiveness of the −4SD morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. No significant differences in the perceptions were recorded, irrespective of reproductive status.

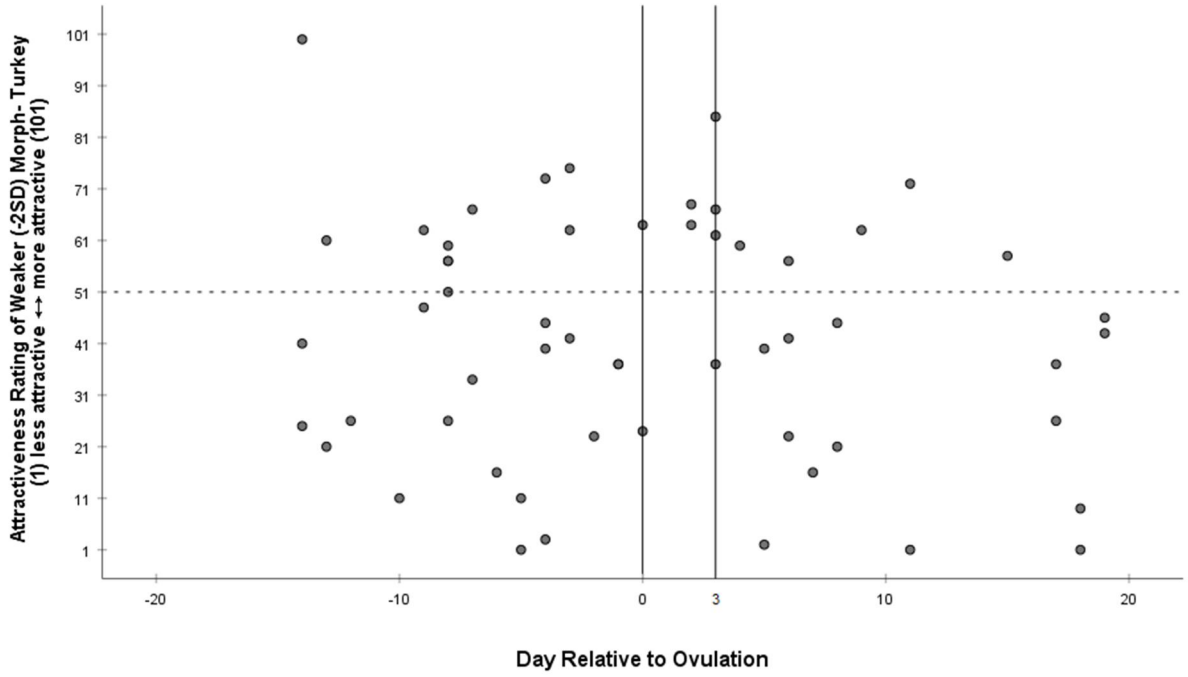

Figure 18: Turkish participants' rating on the attractiveness of the −2SD morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. There are no significant differences in perceptions, regardless of reproductive status.

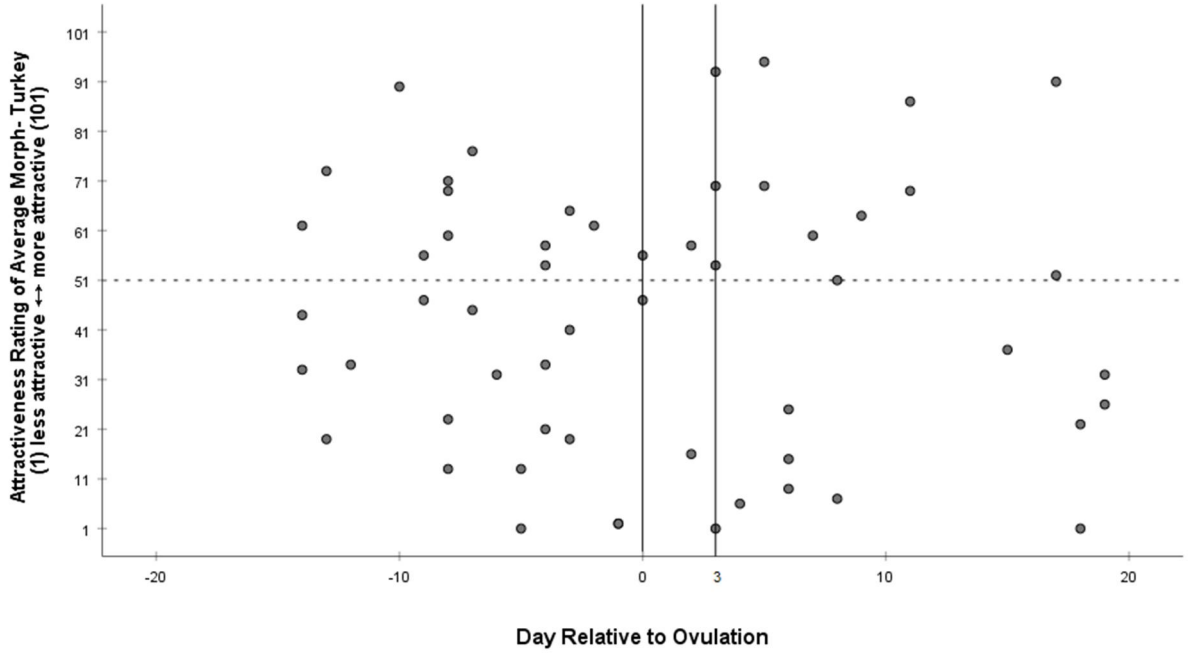

Figure 19: Turkish participants' rating on the attractiveness of the average morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. There are no significant differences in perception, irrespective of reproductive status.

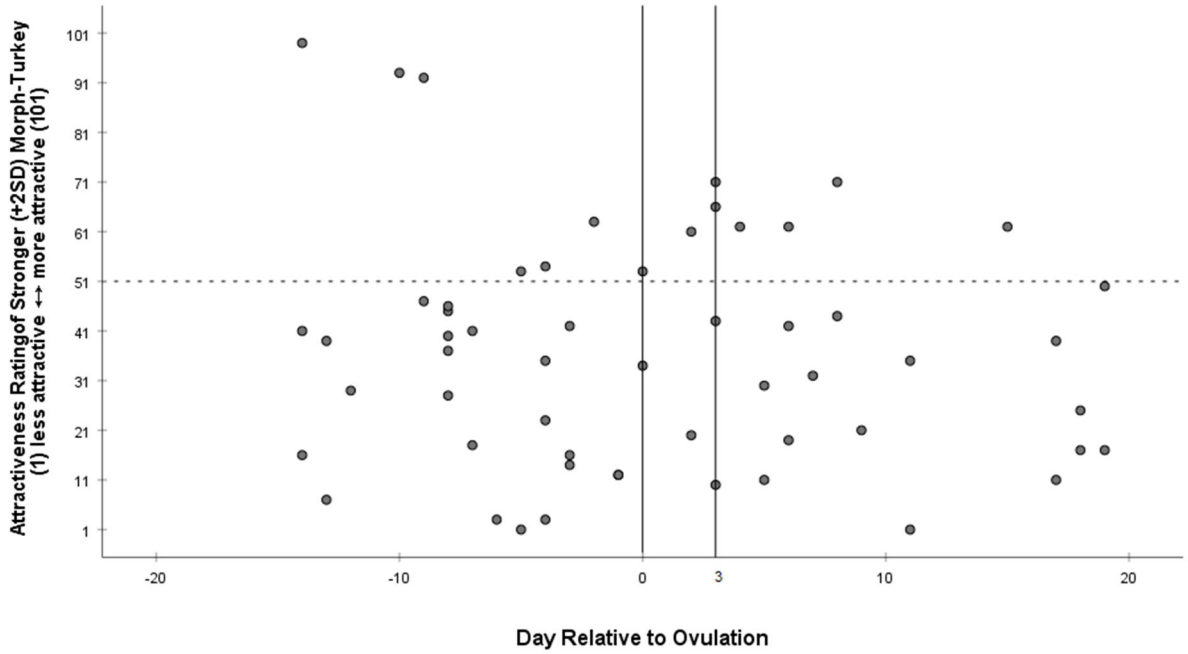

Figure 20: Turkish participants' rating on the attractiveness of the +2SD morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. There are no significant differences in the participants' perceptions, irrespective of reproductive status. Contrary to expectations, three participants at low conception risk found the stronger morph highly attractive**.**

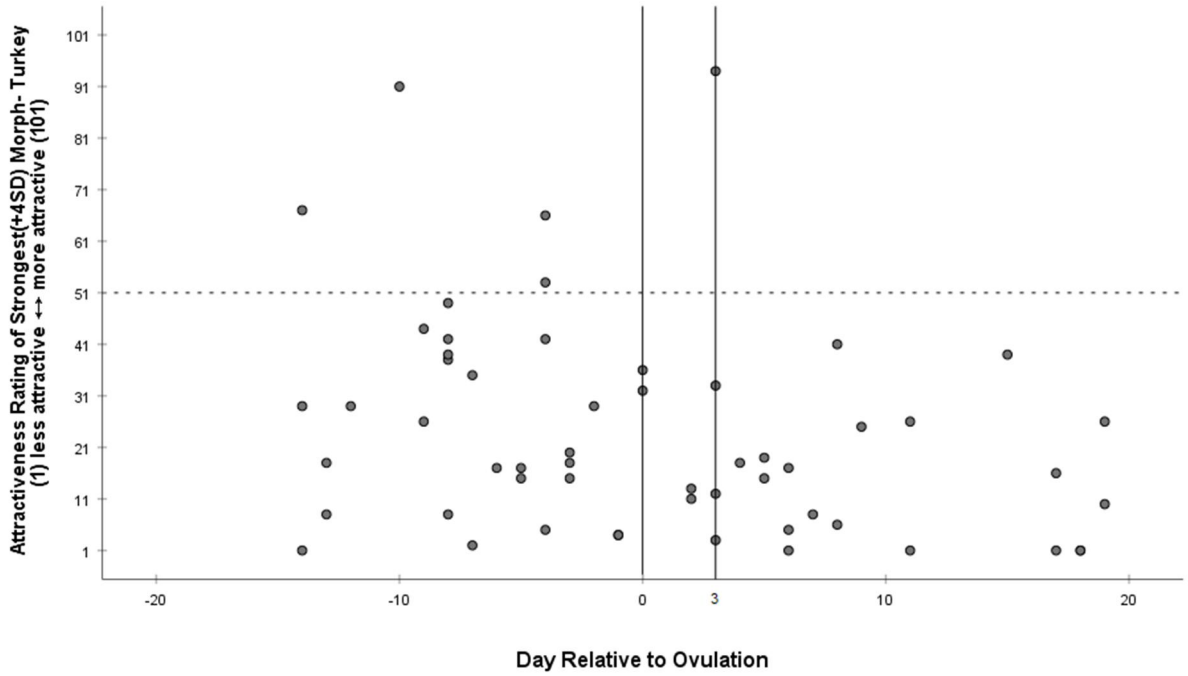

Figure 21: Turkish participants' rating on the attractiveness of the +4SD morph with relation to ovulation days. The date of ovulation (0) and the following three days were regarded as high conception risk. Out of eight, only one participant at high conception risk assessed the strongest morph as highly attractive.

3.6 Non-significant Influence of Relationship Status of Austrian and Turkish Participants on Perception of Attractiveness

The repeated-measures ANOVA test was performed separately due to differences in perception of attractiveness between Turkish and Austrian women.

Out of 104 Austrian women, 43 participants considered themselves partnered, 59 were single, and the remaining two women were neither single nor partnered.

The Austrians significantly related handgrip strength to the perception of attractiveness (Huynh-Feldt F=38.024, p<0.001, partial η2=0.275). The quadratic model showed the greatest effect size (*Huynh-Feldt* F=155.210, p<0.001, partial η2= 0.608).

Single and partnered Austrian participants showed neither significant interaction effects between their perceptions (*Huynh-Feldt* F=0.352, p=0.819, partial η2=0.004) nor any significant differences in their perception of attractiveness (F=0.142, p= 0.708, partial η2=0.001) (Figure 22). The participants judged the −4SD and +4SD morphs significantly less attractive (Bonferroni post hoc tests, p<0.01) than others, except when the two are compared with each other. The post hoc tests on the main effect of relationship status indicated that single Austrian participants gave slightly higher ratings to every morphs than those given by the partnered participants, but the differences were not significant (p=0.708).

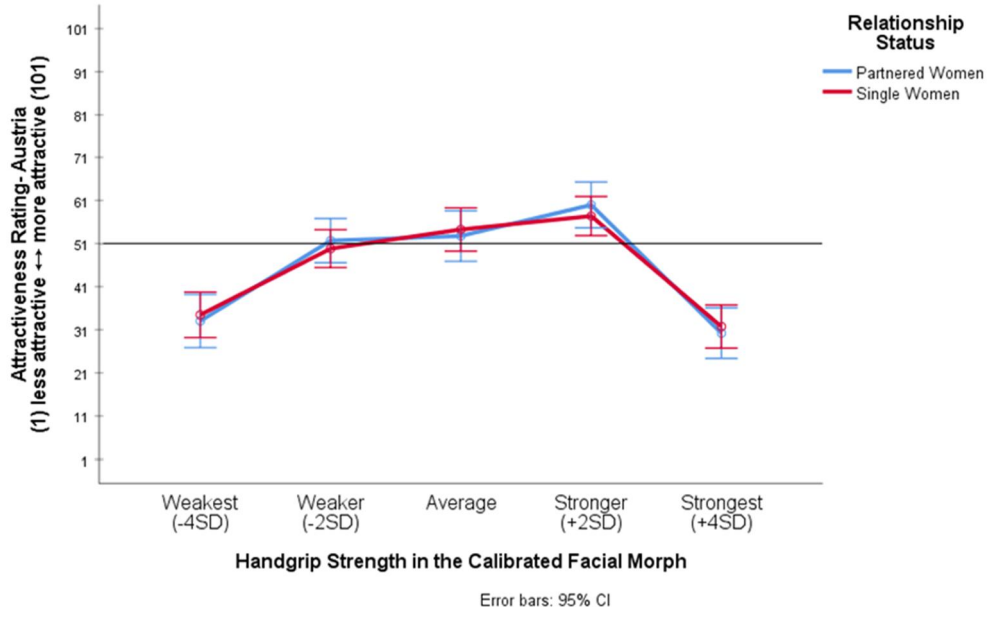

Figure 22: Participants' rating on perceived attractiveness with relation to the actual physical strength with different lines for partnered (*N*=43) and single (*N*=59) Austrian participants. No differences (F=0.142, p=0.708, partial η2=0.001) or interactions (*Huynh-Feldt* F=0.352, p=0.819, partial η2=0.004) were found between perceptions by partnered and single participants

Out of the 109 Turkish participants, 43 considered themselves partnered, 60 were single, and six participants had to be excluded because of uncertain relationship status.

There was a significant main effect of actual handgrip strength on the perception of attractiveness by partnered and single Turkish participants (*Huynh-Feldt* F=21.929, p<0.001, partial η2=0.178). The quadratic model showed the highest effect size (*Huynh-Feldt* F=77.563, p<0.001, partial η2=0.434).

There was significant interaction effect between perceptions by partnered and single Turkish participants (*Huynh-Feldt* F=2.446, p=0.048, partial η2= 0.024). The partial eta squared value of 0.024 is defined as a small-sized effect. There were no statistically significant differences in perception of attractiveness between the partnered and single Turkish women in relation to relationship status (F=0.24, p=0.878, partial η2=0.000). The Turkish participants rated the average morph significantly more attractive (Bonferroni post hoc test, p<0.05) than other morphs, except for −2SD morph. Single Turkish participants did not give significantly higher or lower ratings than those given by partnered Turkish participants (post hoc tests, p=0.878).

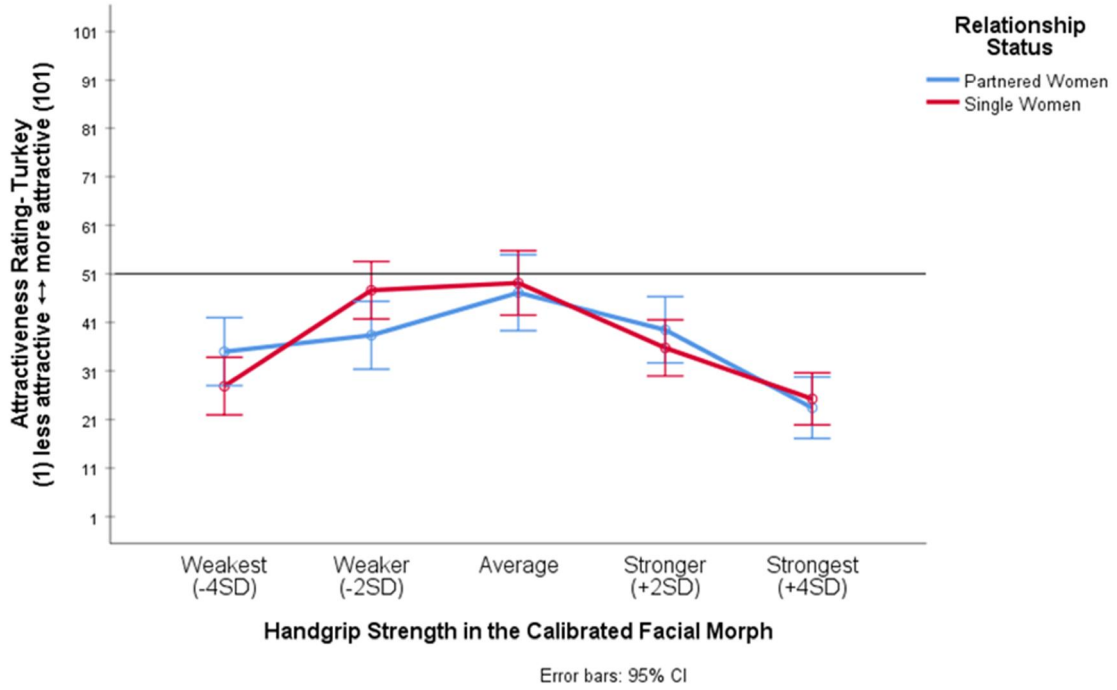

Figure 23: Participants' rating on perceived attractiveness with relation to the actual physical strength with different lines for partnered and single Turkish participants. An interaction was found between the perceptions of partnered and single Turkish participants (*Huynh-Feldt* F=2.446, p=0.048, partial η2= 0.024), but no significant perception differences between partnered and single Turkish participants were observed (F=0.24, p=0.878, partial η2=0.000).

4. Discussion

4.1 Recognising Physical Strength Partly

Several studies (e.g. Sell et al., 2008) reveal that women and men are able to recognise the actual physical strength of men from their facial features. Pronounced features show both sexes how strong these men are and how high their fighting abilities are because they have a high testosterone level. According to Puts (2010), the physical strength of men and being highly masculine are positively correlated with male-male competition and fighting ability. This makes it important to understand the strength of men because in doing so people can better understand their potential antisocial behaviour and negative personal characteristics as well. Additionally, women can then make "better" mating choices in estimating the physical strength of men. The present study focuses solely on women's perception of the actual physical strength of men. Men's perception of the physical strength of the same-sex is not covered here. Nonetheless, including male participants would be an interesting next step. Prucha (2018), who used the same morphs as the present study and did not focus on recognising physical strength, showed that men gave quite similar attractiveness ratings to the morphs as women did in the present study. Accordingly, comparing the judgement of men and women about physical strength can yield meaningful results.

The present study underlines that Turkish and Austrian women could partly recognise actual physical strength based on the morphs. They evaluated the strongest, stronger and average morphs as significantly different compared to the other morphs, but not to each other. One potential explanation could be that the Turkish participants were less familiar with the morphs than the Austrians. This is because people are generally used to evaluating the features of their own population (Zebrowitz et al., 1993). Interestingly, there were no perception differences between Austrian and Turkish participants regarding the physical strength of the morphs. This means that the Turkish participants' different viewpoints are not the reason for not being completely able to recognise the actual strength of all morphs. The Austrian and Turkish participants showed no significant rating differences concerning the physical strength of the individual morphs.

Recognising only the strength level of the weaker morphs, however, can be still meaningful. In contrast to weak men, strong (e.g. greater genetic fitness) and average (e.g.

potential to be a good parent and acceptable genetic fitness) men can give different benefits to women regarding their mating strategy.

Women at high conception risk are known to be much more sensitive than they normally are, particularly regarding visual stimuli (Barris et al., 1980; Macrae et al., 2002). Accordingly, it might be expected that women at high conception risk are also more sensitive to recognising the features of same- or opposite-sex humans. Unfortunately, out of 213, only 14 women were at high conception risk. Many participants (especially Austrians) did not have natural menstrual cycles because they were using hormonal contraceptives. This is no doubt the main explanation for not finding a significant result. Nonetheless, they successfully recognised weak morphs.

4.2 Averageness is Attractive

The main issue in the present study was to test the inverted U-Hypothesis. Attractiveness remains a complex and opaque topic because women's perception of men's attractiveness can be influenced by several factors. In fact, females' perception of opposite-sex attributes is much more complex than men`s perception of women's attractiveness. Some researchers reported that women might consider exaggerated male-characterized traits attractive because such characteristics were associated with greater resource-holding potential, fighting ability, medical health and higher mating success (Rhodes et al., 2003; Sell et al., 2008; Rhodes et al., 2005).

For better mate quality and mating success, perceiving stronger men as attractive might be a reasonable benefit for women, but Frederick & Haselton (2007) reported that women perceived the average man as being more attractive than extremely strong or weak men. Similar to that study, this present study found that women rated the average morph most attractive and the weakest and strongest men less attractive. Importantly, the stronger facial shape is generally characterized not only with greater resource-holding potential, fighting ability and higher mate potential but also with negative personality traits (i.e. coldness, dishonesty, tendency for aggressive behaviours) and with having less potential for taking care of partners and offspring (Perrett et al., 1998). This is because men with higher testosterone levels tend to have also multiple relationships. In the view of women, men with highly masculine traits are much less willing to have a long-term relationship than men with feminine traits (Boothroyd et al., 2008). Being extremely weak, which can in some cases be

characterized as being equivalent to feminine, is unattractive to women: such men may exhibit the least mate quality and resource-holding potential.

Moreover, the morphs were not rated by men in the present study. Including the male rating would be meaningful. Prucha (2018), who used the same facial morphs, reported that men also tend to find the average morph as most attractive. The present results and those of Prucha (2018) and Kerschbaumer (2019) are quite similar, fall using the same facial morphs. Combined, this strengthens the interpretation that both men and women evaluate average facial characteristics as more attractive than stronger and weaker facial characteristics.

Interestingly, Rhodes et al. (2001) concluded that being average was attractive not only because of a higher paternal care potential but also because facial averageness indicated a person's health. Average traits mirror the stability in development, which is also an important health marker (Thornhill & Møller, 1997). Note that heterozygosity may also play an essential role here because it is associated with indicators of developmental health and can increase disease resistance (Thornhill & Gangestand, 1993). Roberts et al. (2005) showed that male facial attractiveness correlated with heterozygosity in the major histocompatibility complex. According to the meta-analysis by Langlois et al. (2000), physical health has a reasonable influence on the attractiveness. Although the present study did not focus on the health of morphs, health could also be a reason for the stronger preference for average men, who have a greater possibility of parental investment.

The factors that may influence women´s judgement about male facial attractiveness are enormous. For instance, the condition of women and their self-rated attractiveness could also influence the perception of women about male facial attractiveness. In the present study, the participants did not evaluate their own attractiveness. Little et al. (2007), for example, maintained that women who rated themselves attractive were more likely to find men with more masculine physical traits attractive.

In the following chapters, some of those factors, which were tested in the current study, are discussed.

4.3 Differences and Similarities between Cultures in Perception of Attractiveness

An important factor tested in the present study was cultural and environmental effects on women's perception of male facial attractiveness. No extreme differences were expected between Turkish and Austrian women, but their perceptions were, in fact, different. Generally, Turkish participants perceived all the morphs as being less attractive, but both

groups judged the average morph most attractive and the strongest/ weakest morphs as least attractive.

In general, women in environments where the availability of resources is scarce may choose men who would invest more in their offspring and have better chances of gathering enough resources (Little & Jones, 2012). Based on data from 2013, the average daily caloric supply, measured in kilocalories per person per day, is 3,768 in Austria and 3,706 in Turkey (Roser & Ritchie, 2020). This makes it difficult to introduce resource availability as a factor because the daily caloric intake is similar.

Nonetheless, women from countries with higher developmental indices show greater preferences for facial masculinity than shown by women in countries with lower developmental indices (Marcinkowska et al., 2019). According to the most current data (2017), the income index is 0.924 for Austria, higher than for Turkey (0.833) (Hdr.undp.org, 2019). This resource factor is interpreted here as a reason for women preferring stronger men. Under the above mentioned circumstances, it could have been expected that Austrian participants prefer stronger men: even though they may exhibit anti-social behaviour and not invest enough in their offspring, they perhaps do offer heathier genes (Hamilton & Zuk, 1982; Johnston et al., 2001; Perrett et al., 1998). Compared to Austrian participants, it could have been expected, that Turkish women prefer weaker men because such men potentially invest more in their offspring and make a greater effort to share limited resources. However, Austrian and Turkish women showed a similar preference pattern in relation to physical strength in this study, which confirms my hypothesis and might highlight averageness as a pillar in evolutionary explanations of attractiveness.

Another focus could be placed on healthcare. Women in environments with poor healthcare and higher pathogen levels show greater preference for more masculine traits compared to women enjoying better healthcare and lower pathogen levels (Thornhill & Gangestand, 1999). In Turkey, women receive less healthcare than women in Austria. According to Human Development Reports of the United Nations Development Programme (UNDP), the Human Development Index of Turkey (0.791, Rank 64) is lower than that of Austria (0.908, Rank 20). The percentage of children less than five years old suffering from malnutrition and other deficiency symptoms was to 9.5 for Turkey. No data were available for Austria. Moreover, in Turkey, the probability of dying between birth and the age of one is 10.9 per 1,000 live births, with the value being 12.7 per 1000 live births between birth and age five. In comparison to Turkey, the child mortality rates in Austria are significantly lower, namely 2.9 per 1,000 live births for under-one infants and 3.5 for children under five years of

age (Hdr.undp.org, 2019). This is reason to assume that Turkish women are more likely to prefer stronger men than Austrian women did.

In kind of interesting way, there were differences between the perceptions of Austrian and Turkish women. The judgment of Austrian and Turkish participants did not differ about agreeing who is most attractive or not. However, every single morph was evaluated as less attractive by Turkish versus Austrian participants. Importantly, the order of morphs' attractiveness was the same for both groups. Moreover, both groups found the same morph attractive or least attractive. According to Zebrowitz et al. (1993), humans are more likely to agree on what makes attractiveness more acceptable in similar facial characteristics in their population than in faces that are not common in their populations. Note that cross-cultural studies are mostly between populations that are visually and environmentally far away from each other, such as Europeans and Japanese or Africans. In the present study involving Austrian and Turkish populations, however, this particular aspect is of reduced importance. Besides, meta-analyses by Langlois et al. (2000), demonstrate that there is strong agreement between different cultures as to who is attractive and who is not. It is clear that certain features mirror "universal adaptation" that is why people from different countries can agree about finding similar faces attractive (Fink &Neave, 2005).

No wonder, there can be also a number of specific traits (e.g. skin colour) that can variously reflect the sign of health, age, reproductive success etc. in different groups (Yarosh, 2019). Humans are able to estimate the health of person with the help of skin colour (Stephen et al., 2009). For example, according to Stephen et al., (2012) women find skin redness attractive because skin blood perfusion and oxygenation affect the perception of humans about health of others (Stephen et al., 2009). Additionally, women have their lightest skin colour around their ovulation (Frost, 1988) and have generally paler skin than men because vitamin D is needed during pregnancy (Diamond, 2005; Jablonski & Chaplin, 2000). For this reason, darker skin colour can generally regarded as a male trait. Frost (1994), however, showed that women at the conception risk were more likely to find men with darker skin colour more attractive. This might be because women perceive male-like traits as more attractive during their high reproductive phase. Turkish people, however, have on average darker skin colour than Austrians. According to Relethford (1997), "*for every 10 degrees of north latitude, skin reflectance increases roughly 8.2% in males and 8.1% in females*" (p. 454). Austria and Turkey are in the northern hemisphere. The latitude of Austria (47.516231) is higher than Turkey's (38.963745), with 9 degrees latitude difference (Google Developers, 2019). This geographical positioning points to darker skin colour in Turkey. That difference is

not extreme, but the visual experience might influence the way humans view certain features that may or may not be common in a population (Zebrowitz et al., 1993). Thus, Turkish participants are more familiar with men who have darker skin. Turkish women could recognise what was attractive and what was not, but they might also rate all morphs less charitably than done by Austrian participants, who are very familiar with middle European facial features.

According to Rhodes et al. (2005), humans tend to regard facial features of mixed populations as more attractive and they also prefer the faces with common features in their population to faces of other populations. Being familiar with certain traits plays an important role in this case, and such familiarity needs not be confined solely to facial features of own population (Coetzee et al., 2014). This is because, in today's world, people are familiar with European facial characteristics thanks to the movie industry, for example. This may indirectly play a role in forming personal preferences. These considerations may help explain why Austrians and Turks could agree about attractiveness.

Moreover, both groups of participants were living in cities, which could partially explain the similarities in the results. According to Swami and Tovée (2005), urban Malaysian populations show greater agreement with British populations than that shown by country folk. The agreement witnessed in the present study could have been different if the Turkish participants had come from villages.

4.4 Effect of Reproductive and Relationship Status of Women on Perception of Attractiveness

According to some studies (Penton-Voak et al., 1999; Little et al., 2007), menstruation greatly affects women's mating strategies. Therefore, one expectation is that participants at high conception risk might find the strongest men more attractive compared to their choice in any other phase. Such women tend to maximize the possibility of conceiving and benefiting from men's genetic health. In the current study, being in this phase had no significant effect on the perception of male facial attractiveness.

Accurately assessing reproductive status is a crucial factor. According to Wilcox et al. (2000), it can be difficult to find the exact days of high conception risk even if women state that their menstrual cycle is regular. Clearly, the effect of reproductive status on the perception of male attractiveness is much more complex than previously thought.

The main reason behind the lack of a positive result in the present study might be that only six Austrian and eight Turkish participants were at high risk of conception during the test. Clearly, the sample size of participants at high conception risk was insufficiently large to obtain meaningful results.

Interestingly, Little et al. (2007) found that women view male-characterized features as most attractive during high conception risk phase, but only for short-term relationship. Since few women were at high risk of conception, this hindered fully testing the effect of reproductive status on women. Nonetheless, evaluating the relation between being at high conception risk and rating the morphs as attractive for a long- or short- term relationship would be an important next step.

The status of being in a long- or short-term relationship affects the mating strategies of women. Women generally prefer long-term mating to short-term engagements (Buss & Schmitt, 1993). Men find similar female characteristics attractive for both long- and short-term relationships, but they are more likely to attach importance to physical attractiveness for a short-term versus long-term relationship (Currie & Little, 2009). Women, in contrast, can show different preferences for short- and long-term relationships.

As in all other human behaviours or preferences, these choices are also complex and have several effects. Thus, women are likely to choose more masculine traits for short-term than for long-term relationships (Waynforth et al., 2005). For the former, women focus on the benefit of fitness, but for the latter, parental investment plays a more important role. This explains why such preferences are correlated with the relationship status of women. Little et al. (2002) showed that women tend to perceive masculine traits much more attractive at conception risk if they were currently in a relationship. This can be explained by the reason of having already a long-term partner who would invest in offspring. In contrast, women without a partner prefer less masculine men, who are potentially more sociable than those with more masculine traits.

The current study predicted that partnered women tend to view stronger men as more attractive than single women do. Nonetheless, no effect of the relationship status on women's judgement about male facial attractiveness was found. This result can be influenced by many factors. For example, it is important to precisely define "being in a relationship". In the current study, some of the participants defined themselves as partnered, but their relationship was only weeks old. Yet, others might speak of being in a relationship only when thinking about marriage or planning a future together with the current partner. Thus, an imprecise definition could be quite confounding.

The majority of the literature showed that women judge male attractiveness by considering them either long term or short term partner (Penton-Voak et al., 2003; Little & Jones, 2012). In the present study, participants rated the attractiveness of the morphs in a general way: they had neither a definition of what a short- or long-term relationship was. It is possible that, if they had been provided with a strict definition, their replies would have been different and the results more meaningful.

DeBruine et al. (2006) showed that women who were in a relationship preferred strong facial characteristics similar to those of their current partners. Moreover, the partner´s attractiveness and the satisfaction of women in the current relationship play an important role in the attractiveness preference of women (Haselton & Gangestad, 2006). Such additional information would be helpful in elucidating the bigger picture of the effect of relationship on the female perception of men's facial attractiveness.

In summary, in the current study, five morphed faces of men defined by handgrip strength were evaluated by Austrian and Turkish female university students. It was found that women only partly recognised the physical strength of these morphs through facial correlates of their handgrip strength. Most interestingly, both the Austrian and Turkish participants rated the average morph as being most attractive. The use of inverted U-form helped understand women's perception of male facial attractiveness. Differences between Austrian and Turkish participants' perception of men's attractiveness were not expected but, interestingly, the Turkish participants judged all morphs to be less attractive than the Austrians did. No relationship was found between women's reproductive status and attractiveness judgement as well as relationship status and attractiveness ratings. A larger sample size of women at high conception risk would have been required to confirm or reject. The most significant limitation to testing the effect of relationship status was posed by the definition of being in a relationship and that of attractiveness. Better understanding the implications of these results calls for evaluating the participants' satisfaction in their current relationship and their partner's strength as well as attractiveness: this is the prerequisite for properly estimating the effect of the relationship status of women on their perception of male attractiveness. The use of geometric morphometric morphs has only recently been added to the scientific toolkit. This study shows how they help a scientific account of first impressions by allowing to trace the response pattern to a single biological predictor such as physical strength.

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