BEHAVIORAL DISPLAY OF LUMBAR CURVATURE

IN RESPONSE TO THE OPPOSITE SEX

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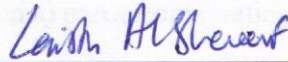THE DEGREE OF
MASTER OF SCIENCE
IN
NEUROSCIENCE

By

Zeynep Şenveli

June 2017

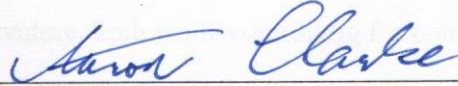# BEHAVIORAL DISPLAY OF LUMBAR CURVATURE IN RESPONSE TO THE OPPOSITE SEX

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June 2017

We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.
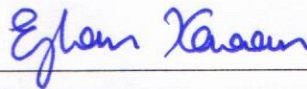
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Abstract

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The aim of this thesis was to investigate the hypothesis that women adjust their lumbar curvature to approach the suggested biomechanical optimum of 45.5 degrees in response to the presence of an attractive member of the opposite sex. The experiment was designed to examine the relationship between a) participants' ratings of an attractive male confederate and the displayed change in deviation from the optimum displayed by women, and b) participants' ratings of the attractive male confederate and the displayed change in the absolute degree of lumbar curvature, both while controlling for potential confounds such as participants' self-perceived physical attractiveness, self-esteem, personality traits, and socio-sexual orientation. Initial statistical analyses revealed a significant change in participants' lumbar curvature pre- to post-exposure to the attractive male confederate. Subsequent analyses to examine the nature of the change indicated that socio-sexual orientation reliably predicted the change in lumbar curvature, but not the change in deviation from the optimum. The remaining variables predicted neither the change in lumbar curvature nor the change in deviation from the optimum significantly. This study is aimed at increasing our understanding of the behavioral display of lumbar curvature for self-promotion purposes in response to the presence of opposite sex.

Keywords: Lumbar curvature; behavioral display; physical attractiveness; mate preference; female sexual behavior

Özet

Zeynep Şenveli

Nörobilim, Yüksek Lisans

Tez Danışmanı: Laith Al-Shawaf

Haziran 2017

Bu tezde, kadınların çekici buldukları karşı cinsten bir birey karşısında omurgalarını varsayılan optimal lombar lordoza (45.5 derece) yakınlaştırmak için omurgalarında değişiklik yapacakları hipotezi incelenmiştir. Deney düzeneği, a) katılımcıların deneyde rol alan erkek asistanı ne kadar çekici bulduklarını gösteren değerlendirme ile katılımcıların optimum lordozdan sapma miktarı arasındaki ilişki, ve b) katılımcıların deneyde rol alan erkek asistanı ne kadar çekici bulduklarını gösteren değerlendirme ile sergilemiş oldukları lordoz miktarı arasındaki ilişkiyi incelemektedir. Bu inceleme esnasında ilişkiyi etkilemesi mümkün olduğu düşünülen çeşitli faktörler (katılımcıların kendilerini ne kadar çekici bulduğu, özgüvenleri, kişilik özellikleri ve sosyoseksüel oryantasyonları) göz önünde bulundurulmuştur. Birincil analizlerin sonucunun gösterdiği üzere katılımcıların erkek asistanı görmeden önce ve gördükten sonra sergiledikleri lordoz miktarında istatistiksel önem taşıyan bir fark elde edilmiştir. Bu değişikliğin sebebini anlamak amaçlı yapılan analizler sonucu, önceden belirtilmiş olan faktörlerden yalnızca sosyoseksüel oryantasyonunun değişikliğe etkisi olduğu bulunmuştur. Geri kalan faktörlerin analizi yapılan iki ilişkiye de (a ve b) istatistiksel anlamda önem teşkil eden bir etkisi olmadığı görülmüştür. Bu çalışmanın kadınların karşı cinsten çekici buldukları bir birey karşısında kendi çekiciliklerini arttırmak amacı güderek lombar lordozlarını davranışsal olarak nasıl sergiledikleriyle ilgili anlayışımızı arttırması amaçlanmaktadır.

Anahtar kelimeler: Lombar lordoz, davranışsal sergileme, fiziksel çekicilik, eş tercihi, kadın cinsel davranışları

Acknowledgements

Contents

1. Introduction

Darwin's theory of sexual selection (1859) has served as a groundwork for a sizeable body of research on the physiology and psychology of mating, yet a comprehensive answer to what is desirable in a mate remains elusive to this day. One thing we *do* know is that members of one sex that possess desirable qualities out-compete those who do not in getting selected as mates by members of the opposite sex. Darwin (1871) termed this mate selection process "female choice", because for many species, he had observed males to possess conspicuous ornaments such as the "gorgeous plumage" and "strange antics" (1859, p. 137) of the bird-of-paradise or the deer's antlers, and act pugnaciously in their courtship behavior; while females seemed to lack such diversity in their sexually dimorphic traits, and act choosier in their mate selection compared to males.

Darwin's observations were supported by subsequent findings such as parental investment theory. Trivers (1972) argued that differential parental investment, i.e. the difference between the investment made by the two sexes in their offspring, makes it beneficial for the heavily-investing sex to be more selective in their mate choice. In most species, because females invest more heavily than males through both gestation and rearing (and thus have more to lose in the case of a poor mating decision), evolution would have favored females with the ability to discriminate among potential mates. Subsequent findings (e.g., Fisher, 1930; Trivers, 1972; Andersson, 1982; Kirkpatrick & Ryan, 1991; Paul, 2001) have shown that choosy females were a powerful driving force in the evolution of exaggerated sexual traits and courtship displays of males. As a result, scientists have paid more theoretical and empirical attention to female choice than male choice (e.g., Trivers, 1972; Smuts, 1987; Buss, 1988; Andersson, 1994; Rosvall, 2011; Byers, Hebets, & Podos, 2010; Vaillancourt & Sharma, 2011; Geary, 2010).

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1.1. Evolution of female choice and male sexual characteristics

In the social sciences, throughout history, attractiveness has usually been deemed arbitrary (e.g., Berscheid & Walster, 1974; Langlois et al., 1987). However, approaching this arbitrariness using an evolutionary framework has shed light on the nature of attractiveness. Empirical evidence from non-human animals suggests that attractive traits are not arbitrary – they are precisely the traits that help solve adaptive problems related to survival and reproduction (e.g., Norris, 1993; Petrie, 1994). But the adaptive problems men and women faced in ancestral times were vastly different, which is why male and female standards of attractiveness have evolved to be highly dimorphic (Symons, 1979). Females (of species with conventional sex roles) have evolved preferences for males who display the ability and willingness to invest resources such as food, shelter, and protection both for herself and her offspring (Trivers, 1972, p.142). This gives the female and her offspring immediate material advantage, as well as genetic, economic, and social benefits. Hence, males (of those species) who provide such resources increase their chances of getting selected as a mate. A well-documented example for male display of the ability to acquire material resources is the scorpionfly (*Panorpa cognata)* (Engqvist, 2009). Competent and healthy male scorpionflies provide the female with a nuptial gift, which can be in the form of salivary secretions or a prey offering. Males in worse condition or who are less competent fail to provide the female with any gifts. In turn, females prefer to mate with those who provide such gifts, because they draw nutritional benefits, on top of experiencing an increase in their fecundity followed by the consumption of the food (Engqvist, 2006).

Ability to provide resources is only one way males gain sexual access to females. Research on species where the male provides no obvious resources has shed light on why such a wide array of extravagant male sexual characteristics might have evolved. Some studies report that these allow females to make an accurate assessment of the bearer's quality

both as a mate or a parent, because they reliably correlate with survival- or reproduction-related information, such as the bearer's age or size (Davies & Halliday, 1978), or degree of parasitic infection (Hamilton & Zuk, 1982; Borgia & Collis, 1989), all of which are essential for a female in search of a mate. Other studies have shown that the presence of elaborate ornamentation in males predicts the health, survival, or the developmental profile of the offspring they could later sire (Petrie, 1994).

One of the most famous examples for an extreme male sexual characteristic is the bright plumage found in numerous polygynous avian species. Birds-of-paradise, for instance, are the product of thousands of generations of past female choice (Female Choice and the Birds-of-Paradise, 2011). Darwin erroneously suggested that such bright colors were attractive to females because they held "aesthetic value". However, over the last century, ornithologists, zoologists, and ethologists have made multiple attempts at explaining their adaptive function (e.g., Møller & Pomiankowski, 1993). Hamilton and Zuk (1982)'s work on North American passerines tested the "bright male hypothesis", which suggests that a female might be taking the brightness of male plumage as an indication of the male's resistance to disease. By mating with these disease-resistant males, she would increase her chances of producing disease-resistant offspring. An alternative explanation is "parasite avoidance", where satin bowerbird (*Ptilonorhynchus violaceus*) females are expected to avoid mating with dull-colored males in order to reap a relatively more proximate benefit such as decreasing their own likelihood of parasitic infection (Borgia & Collis, 1989). On the other hand, Zahavi (1975) postulates in his "handicap model" that the expression of this expensive ornament is a direct reflection of the bearer's ability to efficiently utilize metabolic resources, and is therefore an indicator of superior physiological condition. Even though a consensus amongst the suggested models is non-existent, all models support the idea that parasite-free males that

are able to successfully communicate their viability to potential mates have greater reproductive success and sire high quality offspring.

A broader look at such ornaments revealed that what was attractive to females was not only the presence of the bright pigments per se, but also the way they were *displayed* by the bearer. A well-documented case of multi-modal sexual display is that of a jumping spider's. A mature *Maratus* male has a conspicuously colored abdomen and an elongated third leg. High-speed video analyses on peacock spider (*Maratus volans*) courtship displays revealed that by rapidly moving their colorful abdomens, males create simple vibrations. These vibrations comprise a major part of the display, which is occasionally accompanied by drumming and stridulating with their elongated third leg (Girard, Kasumovic, & Elias, 2011; Girard & Endler, 2014). This performance is key to whether the female selects the male for copulation, as females seem to put a great deal of importance on a prospective mate's motor performance during the courtship display (Byers, Hebets, & Podos, 2010). Rypstra and colleagues (2003) have shown those males who performed more body shakes and leg raises had considerably higher reproductive success than those who performed fewer. Multiple explanations have been proposed for why motor skill is deemed attractive by females. By performing these rituals, males display their superior mobility, greater health, ability to elude predation, as well as mental and anatomical developmental stability (or lack of 'developmental stress') (Nowicki, Searcy, & Peters, 2002), all of which contribute to the bearer's survival and reproductive value. Therefore, the male's ability to vigorously repeat such energetically costly rituals helps the female compare her prospective mates in terms of quality.

Exaggerated male sexual characteristics also occur in animals with whom humans shared more recent ancestors, such as primates. Adult male mandrills (*Mandrillus sphinx)* are a good example of this. In his book *The Descent of Man, and Selection in Relation to Sex* (1871),

Darwin refers to the male mandrill as appearing to have "acquired his deeply-furrowed and gaudily-coloured face from having been thus rendered attractive to the female" (p. 296). Consequently, his observations were elaborated by a number of empirical primatology field studies. The coloration intensity of male mandrill's genitalia was found to be condition-dependent, and positively correlated with plasma testosterone levels, testicle size, and determined the bearer's rank in the dominance hierarchy, which had a direct impact on his mating success (Setchell & Dixson, 2001a, 2001b; Wickings & Dixson, 1992). The relationship between genitalia coloration and mating success has been studied extensively (e.g., Setchell & Wickings, 2005). Lower-ranking males with pale sexual skin indeed had considerably less mating and reproductive success than brightly-colored, higher-ranked males (Wickings, Bossi, & Dixson, 1993). Dixson published a comprehensive summary of the suggested explanations for the evolution of bright coloration in *Primate Sexuality* (1998, p. 195): "It is entirely possible that a male's ability to develop and maintain these brightly colored structures signals his health and vitality, his ability to tolerate parasites (Hamilton & Zuk, 1982), or to advertise his 'good genes' by producing a costly advertisement, such as one which might increase risk of predation (Zahavi, 1975)".

1.2. Evolution of male choice and female-female competition

"Males are promiscuous and ferociously competitive. Females--both human and of other species--are naturally monogamous. That at least is what the study of sexual behavior after Darwin assumed, perhaps because it was written by men. Only in recent years has this version of events been challenged. Females, it has become clear, are remarkably promiscuous and have evolved an astonishing array of strategies, employed both before and after copulation, to determine exactly who will father their offspring."

— Tim Birkhead, *Promiscuity: An Evolutionary History of Sperm Competition*

Darwin's idea that it is predominantly females that exert mate choice has received almost as much criticism as it has support over the last century. Huxley (1938) asserted that the characteristics and displays amongst males that have been attributed to female choice might have evolved for purposes other than competition for sexual access. This even applies to the model organisms used in support of Darwin's initial claims, such as monogamous bird species with the most salient exaggerated sexual traits. Such criticism of female choice drew attention to the fact that Darwin's views required emendation. Bateman (1948) agreed and further argued that the evidence in favor of Darwin's claims were based solely on the behavior of animals and were, to a large extent, circumstantial and context-dependent. The circumstances under which female choice should prevail are 1) polygynous mating systems, 2) populations with great variance in male mate quality, and 3) a male-biased operational sex-ratio in the population, that is, a greater number of sexually active males than sexually receptive females (Emlen & Oring, 1977), which increases the bargaining power females have in the mating market and foster more competition among males for sexual access to females.

An analogous logic should apply when the conditions are reversed. That is, female competition over sexual access to males should be (and is) observed 1) in mating systems that tend toward monogamy, 2) when females vary greatly in mate quality (Buss, 1988; Paul, 2001), and 3) a female-biased operational sex ratio (Kvarnemo & Ahnesjö, 1996). Female competition should be observed even more clearly when males provide females with limited and valuable resources when resources are scarce and paternal investment is high (Geary, 2010).

Even though it is less prevalent than female choice, there is ample evidence of male choice in the animal kingdom. Species where males exert considerable mate choice range from drosophila (Cook, 1975), through fresh water isopods (Manning, 1975), to mammals

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such as rats (Zucker & Wade, 1968; Krames & Mastromatteo, 1973), collared lemmings (Huck & Banks, 1979), and wolves. Male wolves exhibit stable mating choices for certain females (Rabb, Woolpy, & Ginsburg, 1967). In primates, rhesus monkeys seem to have a "favorite" female that they prefer to mate with (Herbert, 1968), and humans are no exception.

1.3. Male choice and female-female competition in humans

In 95% to 97% of all mammals, males provide little-to-no provisional care for their offspring (Clutton-Brock, 1989). However, there is cross-cultural evidence that humans are one of a few species in which males make substantial investment in the well-being of their offspring (even though females still have larger obligatory parental investment) (Geary, 2000; Hewlett, 1992). Higher paternal investment gives rise to stronger mate choice exerted by males (Buss, 2006), without undermining female choice. Because both sexes engage in the mate selection process, Huxley referred to this system as "mutual selection" (1938), which makes human sexual dynamics considerably more complex than most animals and virtually all mammals.

Mutual selection operates on sexually dimorphic mate selection criteria. Because the adaptive challenges faced by women are relatively similar to non-human animal females, women also prioritize good genes, protection, and provision of social and material resources. However, unlike most non-human animals, women have concealed ovulation (Burley, 1979). This creates an adaptive problem for men: detecting reproductively capable women. Therefore, men put emphasis on fertility (immediate probability of conception per sex act), and reproductive value (future reproductive potential) in a prospective mate (e.g., Buss, 2006).

Because the physical appearance of a woman carries a wealth of information about her fertility and reproductive value, it is valued greatly by men (Buss, 1989). What is deemed physically attractive by men in the physical appearance of a woman largely revolves around

characteristics that are linked to health and youth. Young females on average are considerably more fecund than older females. Therefore, men attend to youthful features, such as big and bright eyes, small lower-jaw, and full lips (Thornhill & Grammer, 1999), small nose (Cunningham, 1986), and a low waist-to-hip ratio (e.g., Singh, 1993) because they are reliable indicators of high levels of estrogen and thus, high reproductive value in women. Features such as clear skin (e.g., Fink & Penton-Voak, 2002), straight and white teeth (Buss, 2006), and facial bilateral symmetry (Thornhill & Gangestad, 1999) are also important in assessing attractiveness, because they are indicative of long-term developmental stability and genetic quality. Therefore, intra-sexual competition among women is expected to center on such characteristics (Buss & Schmitt, 1993).

The nature of female-female competition is vastly different than male-male competition. Unlike men, women are not able to monopolize prospective mates through sheer force, so they usually use strategies other than direct confrontation (Puts, 2010). One of the most prevalent female strategies is self-promotion, which is generally in the form of altering one's physical appearance. Altering physical appearance includes epigamic displays, such as wearing form-fitting clothing and applying various cosmetic products (Buss, 1988). Use of cosmetics is directed towards achieving and displaying the aforementioned standards of beauty such as an evenly toned and unblemished skin, bigger and brighter eyes, and voluminous hair to advertise good genes, health, and fertility to prospective mates. Although few, experimental studies (e.g., Law-Smith et al., 2006) have shown that these tactics indeed increase women's perceived attractiveness.

1.4. Lumbar curvature: A recently discovered standard of attractiveness

One of the recently discovered standards of attractiveness is the lumbar curvature of women. It has evolved to solve the adaptive challenge of a forward-shifted center-of-mass experienced during pregnancy by ancestral bipedal hominin females (Whitcome, Shapiro, &

Lieberman, 2007). An optimal degree of lumbar curvature (i.e. 45.5 degrees) helps decrease the strain and muscular fatigue caused by the fetal load on the spine by shifting the center-of-mass back over the hips. Women with suboptimal curvature are more susceptible to experiencing spinal injuries, and thus decreased foraging efficiency, risking nutritional stress for themselves, their mates, and offspring (Marlowe, 2003). A close-to-optimal curvature would also indicate the bearer's ability to sustain multiple pregnancies and thus her high reproductive value. Therefore, men are expected to (and do) possess evolved psychological mechanisms that attend to cues related to lumbar wedging (Lewis, Russell, Al-Shawaf, & Buss, 2015).

Because lumbar curvature is a cue to high survival and reproductive value in women, we would expect women to use it for self-promotion in a way that is akin to sexual displays observed in vivo in non-human animals. In the presence of a member of the opposite sex of high mate value, we hypothesize that women with suboptimal curvatures will adjust their spines to approach the biomechanical optimum to make themselves more attractive to the male.

2. Methods

2.1. Participants

Thirty-six women (M_{age} = 20.06 years, SD_{age} = 1.41) participated in the study. All participants were Turkish Bilkent University students and recruited through the Bilkent Academic Information system. They were offered the opportunity to receive course credit in exchange for completion of the study. All participants were required to be 18 years of age or older and heterosexual[1].

2.2. Materials

The questionnaires used in this survey employ extant published Turkish adaptations. For questionnaires without Turkish adaptations, we created a valid scale through translation and back-translation (see Appendices for Turkish adaptations of the scales).

2.2.1. Demographics. Demographics included questions regarding the participants' age, nationality, height, etc.

2.2.2. Physical attractiveness. We used the Physical Attractiveness Scale (PAS) from the International Personality Item Pool (IPIP; Goldberg et al., 2006) to measure individuals' self-perceived physical attractiveness. It contains 9 items, such as "I like to show off my body" and "I like to look at myself in the mirror". Items are rated on a 5-point Likert-type scale (1 = "Strongly disagree" to 5 = "Strongly agree"). (Appendix A1)

2.2.3. Self-esteem. Individuals' self-esteem was measured using the Self-Liking Self-Competence Scale (Revised) (SLSC-R; Tafarodi, & Swann, 2001). It was adapted to Turkish by Doğan (2011). The scale consists of 16 items, such as "I am secure in my sense of self-worth" and "At times, I find it difficult to achieve things that are important to me". Items are rated on a 5-point Likert-type scale (1 = "Strongly disagree to 5 = Strongly agree"). (Appendix B1)

2.2.4. Personality traits. To assess participants' personality traits, we used the Ten Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003). It was adapted to Turkish by Atak (2012). Sample items from the scale include "I see myself as open to new experiences, complex" and "I see myself as dependable, self-disciplined". Items are rated on a 7-point Likert-type scale ranging from 1 (Strongly disagree) to 7 (Strongly agree). (Appendix C1)

2.2.5. Sociosexual orientation. We used The Sociosexual Orientation Scale (Revised) (SOI-R; Penke, & Asendorpf, 2008) to assess participants' mating strategy. The scale consists of three different types of questions for assessing attitude, behavior and desire. Example items

for each include "With how many partners have you had sexual intercourse on one and only one occasion?", "I do not want to have sex with a person until I am sure that we will have a long-term, serious relationship" and "How often do you experience sexual arousal when you are in contact with someone you are not in a committed romantic relationship with?", respectively. All items are rated on a 9 point Likert-type scale. The sum of the items is used as a single SOI-R score for each participant, where higher scores indicate a stronger tendency toward uncommitted mating. (Appendix D1)

2.2.6. Attractiveness ratings of the confederate. Participants were asked to rate the attractiveness of the male confederate on a 10 point Likert-type scale (1 = "Extremely unattractive" to 10 = "Extremely attractive") after their photographs were taken.

2.3. Procedure

Participants were told that the study investigated the relationship between the morphological and psychological features of women. This was done in order to keep participants in the dark regarding the nature of our study's hypothesis. Before arriving at the lab, they were instructed to wear or bring form-fitting clothing with them. Prior to the beginning of the study, participants were asked to indicate their consent to participate in the study by clicking the next button on the first page of the online survey. The participants who agreed to participate were then asked to complete the questionnaire in a private computer laboratory without the research assistant in the room. After completion of all forms, the research assistant guided participants to the room where their photograph would be taken. Participants were asked to put on their form-fitting clothing and remove items and accessories, such as purses, wallets, and cell phones from their pockets. The first photograph was taken with the participants' body and face turned 90 degrees away from the camera. For the photograph, participants were instructed to hold their natural posture while they aligned their feet against the edge of a strip of duct tape standing at a fixed distance (1.3m) from the

camera. After taking this photograph, the research assistant feigned having trouble with the camera and informed the participant that she failed to take the picture. The assistant then summoned the attractive male confederate into the room to help. The confederate solved the supposed problem and stayed and watched the assistant take the same photograph again. The confederate stood next to the camera, so that participants could see that they were being watched by the confederate. After their photographs were taken, participants were guided back to the computer laboratory to fill out a survey that asked participants to rate the attractiveness of both the research assistant and the male confederate.

3. Results

The first set of analyses tested the lumbar curvature (LC) change in absolute deviation from the suggested biomechanical optimum of 45.5° pre- and post-exposure to the attractive male confederate. Participants' degree of LC was measured once before and once after they were exposed to the attractive male confederate. These were subtracted from the optimum and their absolute values were used to obtain two deviation scores for each participant (one before and one after exposure). A final deviation score for each participant was calculated by subtracting post- from pre-deviation scores and was used in the first set of analyses. A single sample t-test revealed that the pre- to post-change in deviation from the optimum was non-significant, $t(35) = 0.46$, $p > .05$. The subsequent linear regression analysis results showed that no variables significantly predicted the change in deviation from the optimum.

The second set of analyses tested the change in LC participants displayed pre- and post-exposure to the the attractive male confederate. The variable used in the second set of analyses was computed by subtracting the degree of LC pre-exposure from post-exposure for each participant. A single sample t-test ($M = 1.72$, $SD = 2.49$) indicated a significant change in participants' LC from pre- to post-exposure to the attractive male confederate, $t(36) = 4.15$, $p < .001$. Bivariate correlations were performed with potential confounds to examine the

nature of the change. Socio-sexual orientation was moderately positively correlated with the change in LC ($r(34) = .43$, $p = .01$) (Figure 1).
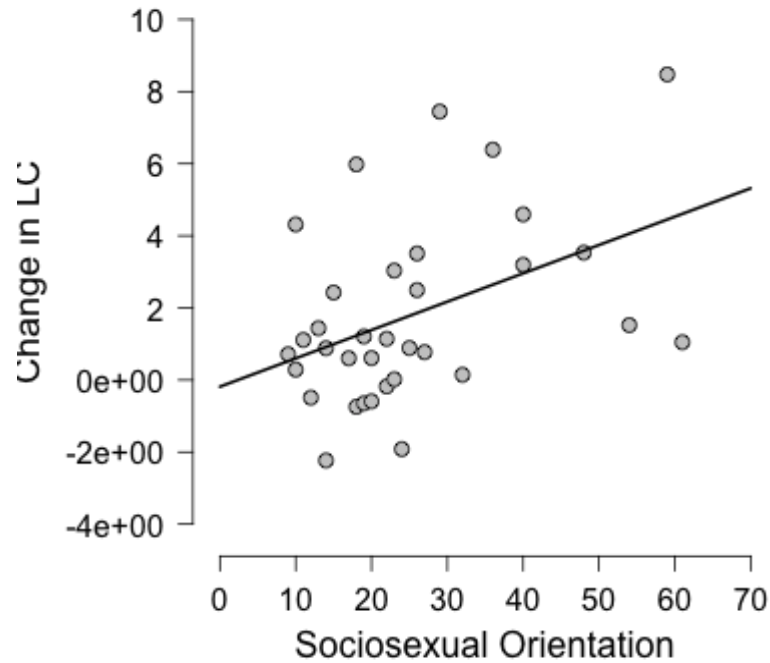
Figure 1. The significantly positive relationship between participants' inclination toward short-term mating and the change they displayed in their lumbar curvature.

However, the remaining confounds: participants' 1) ratings of the male confederate's attractiveness, $r(35) = .04$, $p > .05$ (Figure 2), 2) self-perception of their own physical attractiveness, $r(36) = .05$, $p > .05$, 3) self-esteem, $r(36) = -.03$, $p > .05$, 4) emotional stability $r(36) = .14$, $p > .05$, 5) agreeableness, $r(36) = .06$, $p > .05$, 6) extraversion, $r(36) = -.01$, $p > .05$, 7) conscientiousness, $r(36) = -.158$, $p > .05$, and 8) openness, $r(36) = .15$, $p > .05$ were not correlated with the change in LC. Subsequently, the results of a backward linear regression analysis indicated that sociosexual orientation was the only variable to reliably predict the change in LC ($r(34) = .012$, $p = .01$). Sociosexual orientation also predicted a significant proportion of the variance in the change in LC, $R^2 = .18$, $F(1,32) = 7.17$, $p < .05$. An alpha level of .05 was used for all statistical tests.
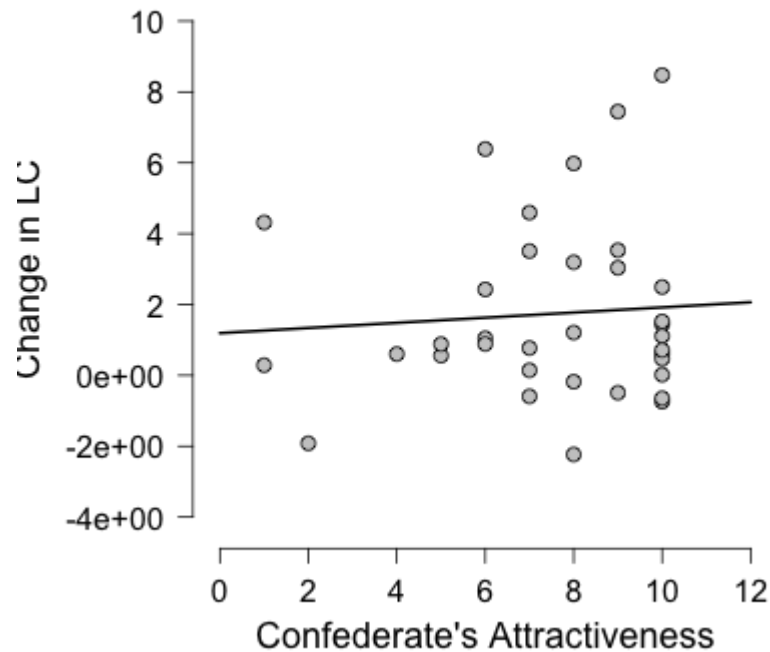
Figure 2. The relationship between participants' ratings of the male confederate's attractiveness and the change they displayed in their lumbar curvature.

4. Discussion

4.1. Summary of findings

Recent findings suggest that women with lumbar curvatures (LC) closer to the biomechanical optimum of 45.5° are better at solving the adaptive problem of a bipedal fetal load (Whitcome et al., 2007), and therefore hold high survival and reproductive value (Lewis et al., 2015). This study was designed to test the hypothesis that women would adjust their LC to approach the suggested optimum when they are exposed to an attractive member of the opposite sex to appear more attractive. The first set of analyses revealed that the participants did not adjust their lumbar curvature to approach the suggested optimum of 45.5° when they are exposed to an attractive member of the opposite sex. Potential factors such as participants' ratings of the male confederate's attractiveness, self-perceived physical attractiveness, personality traits, and self-esteem were included in the analyses, but did not

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predict the change either. This was unexpected and does not appear support the hypothesis that women adjust their lumbar curvature to approach the suggested optimum when they are exposed to an attractive member of the opposite sex. One potential explanation for this could be that males in turn might possess evolved psychological mechanisms that detect women with suboptimal curvatures. This might discourage women from adjusting it temporarily to make it look optimal.

Subsequently, a second set of analyses were conducted to test whether there was a change in lumbar curvature in response to the opposite sex that was not tethered to the suggested optimum. As opposed to using the optimum as an anchor point, the second set of analyses were performed using the raw LC measurements taken from participants. These analyses showed that participants significantly increased their lumbar curvature from before they saw the attractive confederate to after they saw him. Further analyses were conducted to investigate the nature of this change in LC. Potential confounding factors: participants' ratings of the male confederate's attractiveness, self-perceived physical attractiveness, personality traits, and self-esteem did not predict the change. The only variable that predicted the change was participants' socio-sexual orientation scores, i.e. their inclination toward short-term mating. Participants who indicated a greater inclination to engage in short-term mating displayed a greater increase in their lumbar curvature in response to the male confederate.

The suggested optimum of 45.5° is aimed at solving the adaptive problem of a debilitating fetal load experienced specifically by bipedal hominin females. The current set of results, even though provided no support for a display of change anchored to this optimum, rather provided support for a change that was unanchored to the optimum, and is potentially aimed at solving a different adaptive problem of attracting a member of the opposite sex of high mate value. The positive relationship between participants' inclination toward short-

term mating and the change they displayed in response to the attractive confederate, seems to be more consistent with an alternative evolutionary hypothesis. The alternative hypothesis can be that when women are sexually receptive to a male conspecific, they will engage in lordotic behavior to signal their receptivity. Even though the lordosis behavior was extensively studied in rodents, (e.g., Pfaff & Sakuma, 1979; Park & Rissman, 2011), it is one of the primary manifestations of sexual responsiveness in a variety of mammal species ranging from elephants through horses to felines (Natterson-Horrowitz & Bowers, 2012). For most species, it aids in copulation and is crucial for reproduction. In humans, because it is not crucial for reproduction, lordotic display has not been a focus of human reproductive behavior research. Nevertheless, women do seem to arch their back when flirting and courting a male conspecific of interest (Fisher, 1992). Lordotic behavior might nonetheless be an important aspect of human sexual behavior and not recognized yet. If this interpretation is correct, the current study would be the first demonstration of lordotic display as a cue to sexual receptivity in humans.

4.2. Limitations and Future Directions

When interpreting the results of the current study, certain limitations regarding the measures and samples should be considered. First, the group of participants only consisted of Turkish Bilkent students between the ages of 18 and 25. Lack of diversity in the current sample rules out testing for potential culture-specific inputs that might be relevant to the hypothesis, such as a general disposition (or lack thereof) toward short-term mating. The effect could potentially be observed if the experiment was conducted in a less socio-sexually restricted culture or environment. On top of this, participants were asked to wear form-fitting clothing in a confined room with two strangers being photographed, which might have contributed to low ecological validity. Future studies might consider designing the study in an environment that captures the nature of a realistic mating scenario, ideally without the

context of a school environment. An alternative reasoning would suggest that the lack of support for the hypothesis might stem from a lack of statistical power caused by a small sample size. Even though the effect was not captured with the current materials, most of the results pointed toward the expected direction of the hypothesis. Therefore, replicating the experiment with a bigger and more diverse group of participants might be considered for future studies. Another variable worth considering could be participants' menstruation cycles. It would be reasonable to expect ovulating women to be more inclined to put on a sexual behavioral display (Gildersleeve, Haselton, & Fales, 2014). Finally, future studies might consider using a between-subjects design with each condition featuring either one of the following four: an attractive male confederate, an unattractive male confederate, an attractive female confederate, and an unattractive female confederate might be considered. This would shed light on the different confounding aspects of a sexual display such as female-female competition.

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Appendices

A1 – IPIP Physical Attractiveness Scale

Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence. Please read each statement carefully, and then mark your answer using the following rating scale

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree

1. ___ Am considered attractive by others.

2. ___ Attract attention from the opposite sex.

3. ___ Have a pleasing physique.

4. ___ Like to look at my body.

5. ___ Like to look at myself in the mirror.

6. ___ Like to show off my body.

7. ___ Don't consider myself attractive.

8. ___ Dislike looking at myself in the mirror.

9. ___ Dislike looking at my body.

A2 - IPIP PHYSICAL ATTRACTIVENESS SCALE-TURKISH VERSION

Kendinizi gelecekte olmayı arzuladığınız şekilde değil, genelde olduğunuz şekilde tanımlayın. Aynı cinsiyette ve aşağı yukarı aynı yaşta olan insanlar karşısında kendinizi nasıl görüyorsanız, kendinizi o şekilde dürüstçe tanımlayın. Kendinizi dürüstçe tanımlayabilirsiniz çünkü cevaplarınız kesin bir gizlilik içinde tutulacaktır.

1	2	3	4	5
Hiç Katılıyorum Katılmıyorum katılıyorum	Katılmıyorum Tamamen	Kararsızım		

1.___Başkaları tarafından çekici bulunurum.

2.___Karşı cinsin dikkatini çekerim.

3.___Hoşa giden bir fiziğim vardır.

4.___Vücuduma bakmayı severim.

5.___Aynada kendime bakmayı severim.

6.___Vücudumla gösteriş yapmayı severim.

7.___ Kendimi çekici bulmuyorum.

8.___Aynada kendime bakmayı sevmiyorum.

9.___Vücuduma bakmayı sevmiyorum.

B1 – SELF-LİKİNG SELF-COMPETENCE SCALE (REVİSED) – SLSC-R

Please indicate how much you agree with each of the 16 statements below. Be as honest and as accurate as possible. Respond to the statements in the order they appear. Use the following scale:

1--------------2-------------3--------------4--------------5

Strongly   Strongly

Disagree   Agree

Indicate your responses by placing a number (1-5) in the space provided before each statement.

1. _____ I tend to devalue myself.

2. _____ I am highly effective at the things I do.

3. _____ I am very comfortable with myself.

4. _____ I am almost always able to accomplish what I try for.

5. _____ I am secure in my sense of self-worth.

6. _____ It is sometimes unpleasant for me to think about myself.

7. _____ I have a negative attitude toward myself.

8. _____ At times, I find it difficult to achieve the things that are important to me.

9. _____ I feel great about who I am.

10. _____ I sometimes deal poorly with challenges.

11. _____ I never doubt my personal worth.

12. _____ I perform very well at many things.

13. _____ I sometimes fail to fulfil my goals.

14. _____ I am very talented.

15. _____ I do not have enough respect for myself.

16. _____ I wish I were more skilful in my activities.

B2 – SELF-LİKİNG SELF-COMPETENCE SCALE (REVİSED) – SLSC-R – TURKISH VERSION

Aşağıdaki sorular sizin kendinizle ilgili genel düşünceleriniz ve hislerinizle ilgilidir. Lütfen her soruya ne kadar katılıp katılmadığınızı 5 üzerinden yanıtlayınız. Kendinizi dürüstçe tanımlayabilirsiniz çünkü cevaplarınız kesin bir gizlilik içinde tutulacaktır.

1--------------2-------------3--------------4--------------5

| Kesinlikle | Kesinlikle |
| Katılmıyorum | Katılıyorum |

1. _____ Kendimi değersiz görmeye eğilimliyim.

2. _____ Yaptığım işlerde oldukça yeterliyim.

3. _____ Kendimle oldukça barışığım.

4. _____ Uğrunda çaba gösterdiğim her işi başarabilirim.

5. _____ Kendi değerimden eminim.

6. _____ Kendimle ilgili düşünmek kimi zaman hoşuma gitmez.

7. _____ Kendime karşı olumsuz tutum içindeyim.

8. _____ Bazen benim için önemli olan şeyleri başarmakta zorlanırım.

9. _____ Kendimden gayet memnunum.

10. _____ Zorluklarla başa çıkmada bazen yetersiz kalırım.

11. _____ Kendi kişisel değerimden asla şüphe duymam.

12. _____ Birçok konuda oldukça başarılıyımdır.

13. _____ Hedeflerimi gerçekleştirmede bazen başarısız olurum.

14. _____ Çok yetenekliyim.

15. _____ Kendime yeterince saygım yoktur.

16. _____ Keşke yaptığım işlerde daha başarılı olsam.

C1 – TEN ITEM PERSONALITY INVENTORY (TIPI)

Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

1 = Disagree strongly

2 = Disagree moderately

3 = Disagree a little

4 = Neither agree nor disagree

5 = Agree a little

6 = Agree moderately

7 = Agree strongly

I see myself as:

1. _____ Extraverted, enthusiastic.

2. _____ Critical, quarrelsome.

3. _____ Dependable, self-disciplined.

4. _____ Anxious, easily upset.

5. _____ Open to new experiences, complex.

6. _____ Reserved, quiet.

7. _____ Sympathetic, warm.

8. _____ Disorganized, careless.

9. _____ Calm, emotionally stable.

10. _____ Conventional, uncreative.

C2 – TEN ITEM PERSONALITY INVENTORY (TIPI) – TURKISH VERSION

Aşağıda sizi tanımlayan ya da tanımlamayan birçok kişilik özelliği bulunmaktadır. Lütfen her bir ifadenin yanına, o ifadenin size tanımlama düzeyini dikkate alarak, o ifadeye katılıp katılmadığınızı belirtmek için 1 ile 7 arasında bir rakam yazın. İfadelerde size en çok tanımlayan özelliği dikkate alarak, uygun gördüğünüz rakamı yazın.

1 = Tamamen katılmıyorum

2 = Kısmen katılmıyorum

3 = Biraz katılmıyorum

4 = Kararsızım

5 = Biraz Katılıyorum

6 = Kısmen katılıyorum

7 = Tamamen katılıyorum

Kendimi ………………………………… olarak görürüm:

1. _____ Dışa dönük, istekli

2. _____ Eleştirel, kavgacı

3. _____ Güvenilir, öz-disiplinli

4. _____ Kaygılı, kolaylıkla hayal kırıklığına uğrayan

5. _____ Yeni yaşantılara açık, karmaşık

6. _____ Çekingen, sessiz

7. _____ Sempatik, sıcak

8. _____ Altüst olmuş, dikkatsiz

9. _____ Sakin, duygusal olarak dengeli

10. _____ Geleneksel, yaratıcı olmayan

D1 - THE REVISED SOCIOSEXUAL ORIENTATION INVENTORY (SOI-R)

Please respond honestly to the following questions:

1. With how many different partners have you had sex within the past 12 months?

0	1	2	3	4	5-6	7-9	10-19	20 or more

2. With how many different partners have you had sexual intercourse on one and only one occasion?

0	1	2	3	4	5-6	7-9	10-19	20 or more

3. With how many different partners have you had sexual intercourse without having an interest in a long-term committed relationship with this person?

0	1	2	3	4	5-6	7-9	10-19	20 or more

4. Sex without love is OK.

0	1	2	3	4	5	7	8	9
Strongly disagree				Neither agree nor disagree				Strongly agree

5. I can imagine myself being comfortable and enjoying "casual" sex with different partners.

0	1	2	3	4	5	7	8	9
Strongly disagree				Neither agree nor disagree				Strongly agree

6. I do not want to have sex with a person until I am sure that we will have a long-term, serious relationship.

0	1	2	3	4	5	7	8	9
Strongly disagree				Neither agree nor disagree				Strongly agree

7. How often do you have fantasies about having sex with someone you are not in a committed romantic relationship with?

1 – never

2 – very seldom

3 – about once every two or three months

4 – about once a month

5 – about once every two weeks

6 – about once a week

7 – a few times each week

8 – nearly every day

9 – at least once a day

8. How often do you experience sexual arousal when you are in contact with someone you are not in a committed romantic relationship with?

1 – never

2 – very seldom

3 – about once every two or three months

4 – about once a month

5 – about once every two weeks

6 – about once a week

7 – a few times each week

8 – nearly every day

9 – at least once a day

9. In everyday life, how often do you have spontaneous fantasies about having sex with someone you have just met?

1 – never

2 – very seldom

3 – about once every two or three months

4 – about once a month

5 – about once every two weeks

6 – about once a week

7 – a few times each week

8 – nearly every day

9 – at least once a day

Note for scale use: Item 6 should be reverse-keyed. Items 1 to 3 are aggregated (summed or averaged) to form the Behavior facet, items 4 to 6 form the Attitude facet, and items 7 to 9 form the Desire facet. Finally, all nine items can be aggregated to form a full scale score that represents the global sociosexual orientation, similar to the full score of the original SOI.

D2 - THE REVISED SOCIOSEXUAL ORIENTATION INVENTORY (SOI-R) –

TURKISH VERSION

Lütfen aşağıdaki soruları içtenlikle cevaplayınız:

1. Son 12 ay içinde kaç farklı partner ile cinsel ilişki yaşadınız?

☐	☐	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5-6	7-9	10-19	20 veya daha fazla

2. *Sadece bir* defa cinsel ilişki yaşadığınız kaç farklı partneriniz oldu?

☐	☐	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5-6	7-9	10-19	20 veya daha fazla

3. Uzun süreli bir bağlılık ilişkisi düşünmeden cinsel ilişki yaşadığınız kaç farklı partneriniz oldu?

☐	☐	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5-6	7-9	10-19	20 veya daha fazla

4. Aşk olmadan cinsel ilişki yaşayabilirim.

1 ☐   2 ☐   3 ☐   4 ☐   5 ☐   6 ☐   7 ☐   8 ☐   9 ☐

Kesinlikle
katılmıyorum   Kesinlikle
                                                                        katılıyorum

5. Kendimi, farklı partnerler ile gelişigüzel cinsel ilişki yaşamaktan dolayı rahat hisseden ve bundan keyif alan biri olarak hayal edebilirim.

1 ☐   2 ☐   3 ☐   4 ☐   5 ☐   6 ☐   7 ☐   8 ☐   9 ☐

Kesinlikle   Kesinlikle
katılmıyorum   katılıyorum

6. Uzun süreli ciddi bir ilişki yaşayacağımızdan emin olana kadar birisi ile cinsel ilişki yaşamak istemem.

1 □   2 □   3 □   4 □   5 □   6 □   7 □   8 □   9 □

Kesinlikle   Kesinlikle

katılmıyorum   katılıyorum

7. Bağlılık taşıyan romantik bir ilişki içinde *olmadığınız* biri ile seks yapma fantazilerini hangi sıklıkla kurarsınız?

    □ 1 – hiç

    □ 2 – nadiren

    □ 3 – yaklaşık her iki ya da üç ayda bir kez

    □ 4 – yaklaşık ayda bir kez

    □ 5 – yaklaşık her iki haftada bir kez

    □ 6 – yaklaşık haftada bir kez

    □ 7 – haftada birçok kez

    □ 8 – neredeyse her gün

    □ 9 – günde en az bir kez

8. Bağlılık taşıyan romantik bir ilişki içinde olmadığınız biri ile iletişim kurduğunuzda ne sıklıkta cinsel uyarılma yaşarsınız?

    □ 1 – hiç

    □ 2 – nadiren

    □ 3 – yaklaşık her iki ya da üç ayda bir kez

    □ 4 – yaklaşık ayda bir kez

    □ 5 – yaklaşık her iki haftada bir kez

    □ 6 – yaklaşık haftada bir kez

    □ 7 – haftada birçok kez

    □ 8 – neredeyse her gün

    □ 9 – günde en az bir kez

9. Günlük hayatınızda yeni tanıştığınız biri ile cinsel ilişki kurma hakkında hangi sıklıkta anlık fantaziler kurarsınız?

       □ 1 – hiç

       □ 2 – nadiren

       □ 3 – yaklaşık her iki ya da üç ayda bir kez

       □ 4 – yaklaşık ayda bir kez

       □ 5 – yaklaşık her iki haftada bir kez

       □ 6 – yaklaşık haftada bir kez

       □ 7 – haftada birçok kez

       □ 8 – neredeyse her gün

       □ 9 – günde en az bir kez