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EVOLUTIONARY DETERMINANTS AND HORMONAL UNDERPINNING OF MEN'S MATING STRATEGIES

Correlational and experimental evidence from Chilean samples

POR: Gabriela Paz Fajardo Rodríguez

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PROFESOR GUÍA:
Sr. Pablo Polo Rodrigo

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Abstract

Humans show a wide variety of mating strategies, from promiscuous mating to the establishment and maintenance of long-lasting pair-bonds, with variation between sexes, within sexes, and within-individuals. The following thesis focuses on men's mating strategies, from an evolutionary and a proximate approach, presenting the results from two studies. The first one takes the evolutionary perspective, that proposes the variation on mating strategies can be partially explained by phenotypical, social, and environmental factors. We aimed to investigate the traits associated with men's predisposition to invest in long-term mating to understand the selective pressures that shape the cost-benefit balance that favors men's parental investment. We obtained that socioeconomic status is the main predictor for long-term mating orientation, while strength is highly associated with short-term orientation in men. The second study considers a proximate approach, where testosterone and immediate social context play a major role in regulating individuals' mating strategies. We investigated the testosterone-related and social mechanisms involved in the calibration of long and short-term mating strategies, obtaining that the most relevant factor to explain these strategies is the inclusion of a female confederate in the immediate context where the session was carried out. This manuscript brings together approaches from the ultimate and proximate causes for a better understanding of human mating strategies in men.

General introduction

In the development of every life history, individuals have to face different trade-offs that limit the allocation of available resources. A trade-off is, therefore, every challenge in which they have to balance two behaviors or decisions, where the benefits of one of them go to the detriment of the outcomes of the other. In sexually reproducing species, individuals need to allocate time and energy among different reproductive activities, such as finding and selecting mates, maintaining a pair-bonded relationship, or investing in parental care. The balance in those activities has consequences both at an intra-individual level and an inter-generational level since the costs and benefits are beyond the individual's lifetime (Stearns, 1989, 1992). Since time and energy are limited, this creates trade-offs between different aspects of reproduction, such as the one between mating and parenting. Investing time and energy in mating increases the chances of having more genetically diverse offspring and, especially for males, a more numerous offspring, to the detriment of dedicating time and energy in parenting. Meanwhile, investing in parenting increases offspring's quality and the chances of its survival, decreasing the opportunities of having more diverse and numerous offspring (Stearns, 1989).

In this regard, humans show a wide variety of mating strategies, from the establishment and maintenance of long-lasting pair-bonds –with different degrees of parental investment from men and women– to promiscuous mating (Buss &

Schmitt, 1993; Schmitt, 2015). Both men and women can display short and long-term mating strategies, which involves differences in where the focus is placed: short-term mating strategies prioritize investment in mating with different partners, whereas long-term mating strategies prioritize investment in one partner and in parenting. Despite men and women show variability in mating strategies, there are sexual differences in the expression of these strategies, being men more prone to display a short-term mating strategy than women (Lippa, 2009). The main explanation for these sexual differences is that trade-off between mating and parenting was shaped differently between sexes since they faced different adaptive problems (Buss & Schmitt, 2019). A major difference between men and women, common to most mammals, is that men have less obligated parental investment than women due to their time and energy invested in gestation and lactation (Trivers, 1972). This difference in parental investment has consequences in the features that limit reproductive success in each sex (Clutton-Brock & Vincent, 1991; Trivers, 1972). Men's reproductive success, for instance, is mainly constrained by the access to partners and their default strategy should be establishing non-committed relationships. However, this kind of relationships involve low investment in parental care, and bi-parental care in humans is an important feature that can increase offspring survival, so a long-term strategy may be better in some contexts or for some men (Henrich et al., 2012; Schacht et al., 2017). In turn, women's reproductive success is mainly constrained by access to resources and offspring's survival. Therefore, their default strategy should be

establishing committed relationships; even considering some direct and indirect benefits of establishing non-committed relationships, such as having partners that provide “good genes” or assessing a potential long-term partner (Buss & Schmitt, 2019).

Beyond sexual differences in mating strategies, within-sex –or between-individual—differences are an important source of variability in mating strategies (Schmitt, 2015). From an evolutionary perspective, between-individual variation can be partially explained by phenotypical, social, and environmental factors, including physical features, social status, and mating opportunities that shape different costs and benefits in terms of pursuing different reproductive strategies –or a mixture of them—from one individual to another (Gangestad & Simpson, 2000). Furthermore, a single individual can invest in both mating and parenting simultaneously or in different periods of their lifetime, being within-individual individual differences another relevant level of variability, emphasizing the flexibility of humans’ mating strategies (Schmitt, 2015).

The relative investment in mating versus parenting can be measured through the individual expression of sociosexuality. This concept refers to individual differences in engaging in non-committed sexual encounters. Its main measure is the Sociosexual Orientation Inventory (SOI), which in its first version identifies an individual along a single bipolar continuum, from more restricted or long-term-oriented individuals to more unrestricted or short-term-oriented ones (Simpson &

Gangestad, 1991). A later version of this instrument (SOI-R), reduced the number of items and separated the ones referring to sociosexual attitudes from questions regarding sociosexual behavior (Penke & Asendorpf, 2008), acknowledging that mating preferences do not always get translated into actual mating behavior (Buss & Schmitt, 2019). Jackson and Kirkpatrick (2007) kept the original number of items and proposed a multidimensional understanding of sociosexuality by not only separating attitudes from behavior, but also considering long- and short-term mating orientations as two independent dimensions of sociosexual attitudes. This research is focused on men's long and short-term sociosexuality, and how ultimate and proximate factors influence its expression.

First, related to the evolutionary perspective, there are traits that make men more attractive and requested by the opposite sex, hence, those traits influence men's sociosexual attitudes and behavior since they make them more or less successful in competing for partners (Figueroa et al., 2020; Little et al., 2011; Polo et al., 2019). These traits are mostly physical features associated with good health, "good genes", and competitive abilities (Gangestad & Simpson, 2000). In this regard, evidence suggests that a key trait denoting developmental stability and resistance to diseases is low facial fluctuating asymmetry (Pound et al., 2014; Van Dongen & Gangestad, 2011)—, that is also related to perception of attractiveness (Klingenberg, 2003; Moller & Thornhill, 1998; Rhodes, 2006) but with controversial evidence when linked with sociosexuality (Figueroa et al., 2020; Gangestad & Simpson, 2000; Simpson & Gangestad, 1991; Van Dongen &

Gangestad, 2011). Other relevant traits are the upper-body muscularity and strength, associated with high levels of pubertal testosterone (Evans, 2004) and with success in intrasexual competition (Muñoz-Reyes et al., 2019). These traits are often linked with short-term mating orientation (Lukaszewski et al., 2014; Polo et al., 2019), but Buss and Schmitt (2019) suggest that physical traits related to fighting abilities are also relevant for men long-term mating strategies, since being able to succeed in a fight means that he can protect his partner and offspring from external threats. However, there are no previous studies linking these traits with a long-term mating strategy. A possible explanation is that most of this evidence considers sociosexuality as a one-dimensional continuum construct that goes from a more restricted sociosexuality to an unrestricted one (Sprecher et al., 2013; Townsend, 1993), instead of considering long- and short-term mating orientations as separated dimensions (Jackson & Kirkpatrick, 2007).

Social factors are another set of features that can influence mating strategies, and social status is thought to play an important role (Gangestad & Simpson, 2000). Social status defines an individual's position in a social hierarchy and determines the access to contested resources within a social group, including reproductive ones (von Rueden et al., 2010). This suggests that individuals with a higher position in the social hierarchy can access more sexual partners, so they could benefit more from adopting a short-term mating strategy (Greiling & Buss, 2000; Thomas & Stewart-Williams, 2018). In addition, having resources may alleviate the cost of pursuing a short-term mating strategy in men. However, economic

resources –a trait that may reflect social status – appear to be especially relevant for women when selecting a partner for a long-term relationship, but not for a short-term mating context (Buss et al., 1990; Buunk et al., 2002; Sprecher et al., 1994; Townsend, 1989). This difference between contexts has been found in numerous cultures, with different degrees of gender inequalities, mating systems, and religions (Buss, 1989; Wang et al., 2018). Furthermore, economic resources may influence women's perception of men's physical attractiveness (Dunn & Hill, 2014; Dunn & Searle, 2010; Shuler & McCord, 2010; Wang et al., 2018). All these pieces of evidence combined suggest that economic resources may be important for the expression of both long-term and short-term mating strategies in men. Despite this, the evidence on how these traits are influencing men's sociosexuality is limited, especially for its long-term dimension.

In addition to the evolutionary factors that might have shaped human sociosexuality, there are also proximate mechanisms that have a key role in intra-sex differences and intra-individual flexibility in regulating the deployment of mating strategies according to these relevant evolutionary contextual factors (e.g. acquiring a high social status) (Gangestad & Simpson, 2000; Mazur, 1985; Wingfield et al., 1990). One of them is the hormonal underpinning of sociosexuality, specifically testosterone, that has effects on human behavior, especially in men's mating strategies and social status acquisition (Archer, 2006). There is evidence showing that low levels of circulating testosterone are related to parental investment, while higher levels are linked to a preference for mating

rather than parental effort (Archer, 2006; Gettler et al., 2011; Puts et al., 2015). On one hand, circulating testosterone is linked to aggression (thus, to status acquired by dominance), but it is also related to cooperative behavior, which is related to status acquired by prestige, at least in women (Eisenegger et al., 2011; Von Rueden et al., 2011). At the same time, the effect of testosterone on status-seeking behaviors dependents on some personality traits (Carré et al., 2017), so sociosexual attitudes might be a relevant variable that affects the pursuit of social status by both pathways. In addition to testosterone levels, the immediate social context may play an important role in the display of social status acquisition behaviors and in the reported sociosexual attitudes. One particularly relevant contextual factor is the presence of potential mates, increasing the sociosexual attitudes and desires in men (Archnocky et al., 2016), as well as influencing intra-sexual competition (Arnocky et al., 2014). However, there are only few studies investigating the causal relationship between circulating levels of testosterone and reproductive strategies in men, and none of them has directly intervened the immediate social context where subjects are studied.

Our work focuses on men's mating strategies due to the relevance of the reproductive trade-off between mating and parenting that they face in our species. In the first study, we aimed to investigate the traits associated with men's predisposition to invest in long-term mating to understand the selective pressures that shape the cost-benefit balance that favors men's parental investing. Therefore, we focused on intra-sexual variability and stressed the long-term

orientation to gain knowledge about the traits that play a role in this less investigated mating dimension. In the second study, we investigated the underlying physiological (i.e. testosterone-related) and social mechanisms involved in the calibration of long and short-term mating. In this study, we focused on intra-individual variability, concretely, investigating the effect of circulating testosterone on mating strategies. We also explored the circulating testosterone effect on different mechanisms of social status acquisition, as well as the effect of the presence of a potential mate in the experiment on both mating orientations and on the acquisition of social status. This work brings together approaches from the ultimate and proximate causes, to achieve a better understanding of human mating strategies.

Study 1: Traits related to long-term mating orientation in men

Introduction

As mentioned, men's reproductive success depends mainly on access to partners, so their mating orientations should be conditioned by features that women prefer in them (Buss & Schmitt, 2019). These preferences vary depending on the context, being different traits preferred for short-term and long-term relationships. For short-term mating, women prefer characteristics associated with "good genes" and physical condition, such as low facial asymmetry –related to developmental stability and diseases (Van Dongen & Gangestad, 2011; but see Foo et al., 2017; Pound et al., 2014)—, and muscularity or strength –associated with high levels of pubertal testosterone (Evans, 2004). Traits related to good genes are also preferred for long-term relationships but they are less important than for short-term ones and other features become more relevant, such as economic resources, physical protection (also linked to good genes traits), and willingness to allocate those resources to a single partner and their offspring (Buss & Schmitt, 2019). Whereas several studies found evidence that features preferred by women to short-term mating are, in turn, related to men's short-term mating orientation (Frederick & Haselton, 2007; Hughes & Gallup, 2003; Lukaszewski et al., 2014; Polo et al., 2019), the relationship between traits preferred by women for long-term mating and men's mating orientation are less empirically explored. In this study, we focused on pinpointing if traits attractive for women for long-term

relationships are related to men's long-term mating orientation in order to shed light on the factors that may calibrate the expression of long-term mating strategies in men.

First, economic resources are more relevant to women than to men when it comes to long-term partner selection, compared to short-term mating contexts (Buss et al., 1990; Buunk et al., 2002; Li & Kenrick, 2006; Sprecher et al., 1994; Townsend, 1989). This pattern of sex-differences has been found in numerous cultures with different degrees of gender inequalities, different mating systems, and religions (Buss, 1989; Wang et al., 2018). Resources are generally measured as present income or other material assets, and several studies point towards the importance of having resources to be considered a good long-term partner to women (Anderson & Klofstad, 2012; Fales et al., 2016; Hitsch et al., 2010; Kenrick et al., 1990; Li et al., 2002; Townsend & Levy, 1990). Furthermore, economic resources may influence women's perception of men's physical attractiveness (Dunn & Hill, 2014; Dunn & Searle, 2010; Shuler & McCord, 2010; Wang et al., 2018). Other measures of economic resources are personality traits such as the thriving or ability to generate real resources –measured as educational level or personality traits as intelligence, ambition, or industriousness— and are deemed desirable for women while choosing a long-term partner (Marlowe, 2004; Souza et al., 2016). In addition to this evidence that links resources with long-term preference, there are other studies that suggest that economic resources may also be preferred by women in short-term partners. In this regard, Greiling and Buss (2000) found

empirical evidence that one of the possible functions of short-term mating for women is to obtain resources from casual partners (resource acquisition hypothesis) and, therefore, men signaling resources or status may be preferred for short-term relationships as well. Another study found that priming women with wealth cues produced a shift toward selecting more mates for short-term relationships (Thomas & Stewart-Williams, 2018). In addition, having resources may alleviate the cost of pursuing a short-term mating strategy in men. All these pieces of evidence combined suggest that economic resources may be important for the expression of both long-term and short-term mating strategies in men. To our knowledge, only three studies have reported a link between resources and men's mating strategies measured through their sociosexuality. In one of these studies, Townsend (1993) found that, among college students, those that reported higher expected income had more unrestricted sociosexuality suggesting a preference for short-term mating. However, the father's education and income were not related to sociosexuality. In more recent studies, Sprecher and colleagues (2013) found a null effect of socioeconomic status on sociosexuality, and Szepsenwol and colleagues (2017). found that early and current environmental predictability but not early socioeconomic status predicted restricted sociosexuality during adulthood; however, they did not consider current socioeconomic status in their analyses. Moreover, neither of these studies specifically aimed testing the relationship between current socioeconomic status and sociosexuality and they used a unidimensional measure of sociosexuality

precluding an assessment of whether economic resources are important for both short and long-term mating. More indirect evidence about the role of economic resources in sociosexuality comes from studies using the Wealth subscale included in the Components of Mate Value Survey (Fisher et al., 2008). Fisher and colleagues (2008) found a positive relationship between this subscale and the number of long-term relationships reported by women but not by men. In addition, a recent meta-analysis found that mate value was related to unrestricted sociosexuality (Arnocky et al., 2021), but is not clear if the Wealth component of mate value contributes to this relationship.

Another relevant feature preferred in a long-term mate is being able to provide physical protection to a single partner and their offspring against external threats, giving them an advantage for survival (Buss & Schmitt, 2019). Men's ability to provide this protection is mainly related to the strength of the upper-body (Puts, 2010; Sell et al., 2012), which is highly correlated with hand-grip strength (Gallup & Fink, 2018). Since protection is always given against external threats –including, but not exclusively, other men—, protection traits are also related to higher intrasexual competitive abilities (Muñoz-Reyes et al., 2019). As mentioned before, previous studies usually link strength and muscularity with women's preferences for short-term mating and with attitudes and behavior related to short-term mating strategies in men (Frederick & Haselton, 2007; Hughes & Gallup, 2003). Most of these studies did not consider short and long-term mating orientation as two separate –and sometimes simultaneous-- dimensions of

sociosexuality. However, the only two that took that approach did not find a link between strength and muscularity and long-term sociosexual orientation (Lukaszewski et al., 2014; Polo et al., 2019). This suggests that, if physical traits denoting fighting and protection skills are playing a role in long-term mating strategies, their effect may be contingent upon the possession of other relevant traits in this context such as resources. In other words, protection skills could be relevant for the expression of long-term mating especially in those men that also have real or potential resources.

As important as resources and protection-related traits themselves are for women, there are personality features that signal a willingness to allocate those resources and abilities in one partner and their offspring over a significant period (Buss, 2018; Webb & Fisher, 2018; Zinck et al., 2021). There is cross-cultural evidence that relevant personality traits which women prefer when choosing a long-term partner are kindness, understanding, and commitment (Buss et al., 1990; Buss & Schmitt, 2019; Kenrick et al., 1990; Schmitt, 2005; Simpson & Gangestad, 1992). In this regard, a positive parenthood disposition denotes the willingness to invest in offspring and it is considered an especially relevant component of men's mate value to attract partners for long-term relationships (Fisher et al., 2008). Accordingly, parenthood disposition may be crucial in moderating the effects of resources and protection-related traits in the expression of long-term mating orientation in men.

To sum up, women's preferences in men for long-term relationships are mainly related to economic resources, protection, and the willingness to share those resources and protection with offspring. Accordingly, and following the proposal of SPH, men showing these traits should be more oriented toward long-term mating, as these traits are preferred by women in this context. Moreover, considering a multidimensional measure of sociosexuality, traits denoting resources and protection skills are also expected to be related to short-term mating. However, there is little evidence of whether these characteristics are associated with men's long-term mating orientation as a separate dimension from short-term mating orientation. This study aims to test if resources –measured as self-reported socioeconomic status—, protection skills –signaled by handgrip strength—and the willingness to share resources and protection— measured indirectly through a parenthood disposition measure from the Components of Mate Value Survey (Fisher et al., 2008)— are related to long-term mating orientation in men, using generalized linear models with laboratory data taken from a Chilean population. Following our argument that the willingness to allocate resources in offspring is a key trait denoting commitment, our first specific prediction was that self-reported socioeconomic status would be positively associated both with long and short-term sociosexual orientation, but for long-term-oriented individuals this would be enhanced by having a more favorable parenthood disposition. As our second prediction, we expected that handgrip strength would be positively related to long-term mating orientation in those men

with high self-reported socioeconomic status with a positive parenthood disposition moderating this effect, but we expected that handgrip strength will be directly and positively linked to short-term mating orientation.

Methodology

Participants

The complete dataset was composed of 212 men between 18 and 38 years old (M = 22.52; SD = 4.65). Given the purpose of this study, we selected heterosexual and bisexual men (N = 197). The data was collected in 2016 in Chile's Valparaiso region through an open call in universities and public places, so we had a wider, more diverse sample from a general population. All the procedures were performed in the laboratory at the institution. Participants signed informed consent forms and the study protocol was approved by the Universidad de Playa Ancha Ethics Committee.

First, participants answered a sociodemographic questionnaire that included information about age, gender, sexual orientation, and relationship status (56.8% single). Then, they answered psychometric questionnaires followed by anthropometric measures. At the end of the session, they received a 5,000 Chilean peso show-up fee (around US$6.10).

Measures

Sociosexual orientation. The relative investment in mating versus parenting can be measured through the individual expression of sociosexuality. We used

Jackson and Kirkpatrick's (2007) Multidimensional Sociosexual Orientation Inventory (MSOI), which fulfills the need for a more complex and multidimensional construct to measure sociosexual attitudes and behavior. It consists of a questionnaire made up of 22 items that can be separated into three dimensions: short-term mating orientation (10 items), long-term mating orientation (7 items), and sociosexual behavior (5 items). The first two dimensions were attitudinal and consisted of a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) with statements like "I could easily imagine myself enjoying one night of sex with someone I would never see again", for the short-term mating orientation dimension, or "I can see myself settling down romantically with one special person", for the long-term mating orientation dimension. The sociosexual behavior dimension consisted of open numeric questions. Internal consistency, measured with Cronbach's alpha, was high for both short-term ($\alpha = .90$) and long-term ($\alpha = .84$) mating orientation.

Socioeconomic status. As our first measurement of real and potential resources, we employed the MacArthur Scale of Subjective Social Status (Adler & Stewart, 2007; Giatti et al., 2012), adapted to the Chilean population. This self-reported measurement consists of a ladder with 10 steps representing the place that participants locate themselves in society and their local social environment in terms of job, income, and educational level. The top of the ladder represents the people who have more money, more education, and better jobs while the bottom represents the people with less money, less education, and worse jobs or who

are unemployed. We considered responses regarding the participant's social position in overall society. We expected to have greater heterogeneity in socioeconomic status at the general level than at the local level due to the high socioeconomic inequalities in Chile (PNUD, 2018). In any case, results considering local socioeconomic status instead of global socioeconomic status do not differ in the relationships found.

Parenthood disposition. To capture the willingness to invest in offspring, we used the Parenting subscale from the Components of Mate Value Survey (Fisher et al., 2008). In this subscale, participants responded on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) to three statements. We selected two for this study: "I would make a good parent" and "It is important that the opposite sex views me as a good parent". We excluded the parenting statement "I want to have children in my lifetime" since, as Fisher and colleagues mention (2008), it is possible that a person who wants to have children might not necessarily take care of them and we were more interested in the individual valuation of parenting. The Pearson correlation coefficient between the two considered items is .43, that represents a moderate association (Dancey & Reidy, 2007). It is worth mentioning that neither of these parenting questions is included in the MSOI items.

Protection skills. We measured participants' handgrip strength (in kilograms) with a hydraulic handgrip dynamometer (Jamar® 5030J1) following the procedure of Gallup et al. (2007). Individuals were instructed to be in a stand-up position and

to squeeze the dynamometer with their forearm at a 90º angle to the body. We registered three measurements for each hand, with a one-minute rest between each strength test. We used the highest handgrip strength score.

Body mass index (BMI). This is a trait that covaries with strength and, therefore, it is convenient to control its effect when studying strength-relationships with other traits (Lassek & Gaulin, 2009). The participants' weight (in kilograms) was measured using a digital body scale and their height (in centimeters) was obtained using a stadiometer (SECA 213).

Data analysis

First, we reported Pearson's correlation coefficients between the continuous variables employed in this study and t-test for independent samples to describe differences in these variables according to the relationship status of individuals. Second, to test our hypotheses, we did a between-subjects analysis using generalized linear models with long and short-term mating orientation as dependent variables. Regarding the first hypothesis, we considered global socioeconomic status as an independent variable, and age (in years) and relationship status as control variables. For both dependent variables, we first tested the main effect of socioeconomic status, and then for long-term mating orientation, we included the expected interaction between self-reported status and parenthood disposition. To test our second hypothesis, we considered strength as an independent variable and BMI, age, and relationship status as control

variables. We first tested the main effect of strength, and then, for long-term mating orientation, we included the expected interaction between strength, parenthood disposition, and self-reported socioeconomic status. Relationship status and age were statistically controlled because previous studies showed that they may have an effect over different aspects of sociosexuality (e.g., Penke & Asendorpf, 2008; Polo et al., 2019; Simpson & Gangestad, 1991).

We used generalized linear models because the responses of the dependent variables were independent (i.e., every case was independent), it does not need to satisfy homogeneity of variance nor normality of errors, and it uses maximum likelihood estimation (MLE) instead of ordinary least squares (OLS) to estimate the parameters. We reported standardized regression coefficients for all the models. We used the Pearson Correlation test to test collinearity between independent variables and the results were non-significant, with every coefficient under .30.

Finally, given the results obtained, we carried out an additional exploratory analysis to investigate the possible mediating role of parenthood disposition in the relationship between self-reported socioeconomic status and long-term mating orientation. Mediation analysis was performed using linear regressions and a bootstrapping method (5000 bootstraps and p = 95%) to estimate the significance of the indirect effect.

Mediation analysis was performed with PROCESS macro (version 3.5) for SPSS (Hayes, 2017). All the remaining analyses were performed with R version 3.5.2 employing standard libraries and sjPlot package (Lüdecke, 2021), considering two-tailed tests with a level of significance set up at $\alpha < .05$.

Results

A descriptive summary of the variables employed in this study and mean differences according to the relationship status of the individuals are shown in Table 1. Associations between continuous variables are shown in Table 2.

Table 1: Mean, standard deviation, and mean differences between paired (N = 112) and single (N = 85) individuals for each variable.

	Mean (Std. Deviation)	**Mean differences (single – paired)**
Long-term mating orientation	5.61 (1.42)	0.58**
Short-term mating orientation	4.44 (1.42)	-0.01
Parenthood disposition	10.87 (2.79)	0.17
Global socioeconomic status	5.8 (1.65)	0.37
Handgrip Strength (in kg)	42.8 (7.45)	-0.52
BMI	24.2 (3.51)	-0.45
Age (in years)	22.5 (4.5)	-2.14**

Note: BMI = Body mass index. **p<0.01

Table 2: Pearson's correlation coefficients between variables (N = 197)

	LTMO	*STMO*	*PD*	*Global status*	*Strength*	*BMI*	*Age*
LTMO		.04	.40***	.23**	-.05	-.03	< .01
STMO			.10	.07	.13	-.01	.04
PD				.28***	.02	.08	-.03
Global status					.11	-.00	-.04
Strength						.17*	.04
BMI							.42***

Note: LTMO = Long term mating orientation, STMO = Short-term mating orientation, PD = Parenthood disposition, BMI = Body mass index, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Relationship Between Resources and Mating Orientations

Table 3 shows the main and interaction effects of socioeconomic status for long and short-term mating orientations. Regarding the main effects, we found a significant effect of socioeconomic status (β = .33, t = 3.24, p = .001) on the expression of long-term mating orientation. According to our prediction, individuals with higher socioeconomic status reported higher levels of long-term mating orientation. Regarding short-term mating orientation, we found no main effect on it in terms of socioeconomic status (β = .08, t = 0.76, p = .45).

When considering the predicted interaction for long-term mating orientation, the results showed that parenthood disposition did not moderate the effect of socioeconomic status on long-term mating orientation (β = -.03, t = -0.29, p = .775).

The exploratory mediation analysis showed that the effect of socioeconomic status on long-term mating orientation was mediated by parenthood disposition (indirect effect; β = .099, Bootstrapped SE = .031, 95% bootstrapped CI [.045, .167]). On one hand, socioeconomic status was positively related to parenthood disposition (β = .275, t = 3.95, p < .001), but its direct effect on long-term mating orientation only reached a statistical trend (β = .129, t = 1.88, p = .061). On the other hand, parenthood disposition was related to long-term mating orientation (β = .362, t = 5.30, p < .001).

Relationship between protection skills and mating orientation

Table 3 shows the main and interaction effects of strength over short and long-term mating orientation. First, we found that there was no main effect of strength on long-term mating orientation (β = -.06, t = -0.10, p = .569), but it indeed had a significant main effect on short-term mating orientation, showing that stronger men have a higher short-term mating orientation (β = .21, t = 2.06, p = .041). When including the predicted three-way interaction between strength, socioeconomic status and parenthood disposition with long-term mating orientation, we found a non-significant effect (β = -.02, t = -0.24, p = .811). We also found no significant effects in any of the two-way interactions.

Table 3: Generalized linear model's standardized coefficients and standard errors for long and short-term sociosexual orientation (N = 197)

	FIRST HYPOTHESIS: TESTING SOCIOECONOMIC STATUS		
		Long-Term Orientation	**Short-Term Orientation**
Main effects	**Global status**	0.33** (0.10)	0.08 (0.10)
	Age	0.01 (0.10)	0.13 (0.10)
	In a relationship	0.04 (0.10)	-0.31** (0.10)
	Intercept	5.61*** (0.10)	4.44*** (0.10)
	AIC	696.1	695.6
Interaction effects	**Global status * Parenthood disposition**	-0.03 (0.09)	--
	Intercept	5.62*** (0.10)	--
	AIC	673.1	--
	SECOND HYPOTHESIS: TESTING PROTECTION SKILLS (STRENGTH)		
Main effects (1)		**Long-Term Orientation**	**Short-Term Orientation**
	Strength	-0.06 (0.10)	0.21* (0.10)
	BMI	-0.05 (0.11)	-0.09 (0.11)
	Intercept	5.61*** (0.10)	4.44*** (0.10)
	AIC	707.9	693.6
Interaction effects	**Global status * Strength**	-0.20~ (0.11)	--
	Parenthood disposition * Strength	0.09 (0.11)	
	Global status * Parenthood disposition* Strength	-0.02 (0.10)	--
	Intercept	5.65*** (0.10)	--
	AIC	677.1	--

Standard errors in parenthesis. ***p < 0.001; **p < 0.01; *p < 0.05; ~ p < 0.10

(1) Models with strength and BMI also included control variables (relationship status and age).

(2) For more details, (p-values, control variables and two-way interactions) see the full table in S1 Table.

Discussion

The strategic pluralism hypothesis (SPH) proposes that the relative allocation of time and energy between mating and parenting activities is facultatively calibrated by an individual's particular traits and social context. In this regard, men showing traits preferred by women for long-term relationships should display higher sociosexual attitudes toward long-term mating (Buss & Schmitt, 2019; Gangestad & Simpson, 2000). Previous studies reporting associations between traits preferred by women for long-term relationships and men's sociosexuality are scarce, do not specifically address the mentioned issue, and use a unidimensional approach to sociosexuality (Sprecher et al., 2013; Townsend, 1993). In this study, we tested whether economic resources, protection skills, and the willingness to allocate these resources in offspring –all traits preferred by women in long-term partners—are associated with men's long-term mating orientation. Our results partially support our predictions as we found that socioeconomic status was positively associated with a long-term mating orientation, but parenthood disposition did not moderate this effect. Instead, parenthood disposition seems to mediate this effect. Contrary to our predictions, socioeconomic status did not affect short-term mating orientation. Moreover, we failed to find the expected effects of strength on long-term mating orientation, but we found that strength is positively associated with short-term orientation.

Our first specific prediction was aimed at testing the effect of economic resources on long and short-term mating orientation and whether the willingness to allocate

resources in offspring was moderating the effect for long-term oriented men. Regarding main effects, we found that resources, measured by socioeconomic status, were positively related to long-term mating orientation but did not affect short-term mating orientation. This result is aligned with previous studies that found the possession of resources attractive for women when choosing a long-term partner (Blossfeld & Timm, 2018; Buss et al., 1990; Buunk et al., 2002; Sprecher et al., 1994; Townsend, 1989) and support our prediction that resources are important in calibrating long-term mating orientation in men. In addition, our null result regarding short-term mating orientation is similar to the results of Sprecher and colleagues (2013), in which socioeconomic status was not related to short-term mating strategies but differs from the findings of Townsend (1993) that found a positive relationship. Our prediction regarding the positive relationship between economic resources and short-term mating orientation in men was based on previous evidence suggesting that economic resources may be a relevant trait for women when choosing a short-term mate (Greiling & Buss, 2000; Thomas & Stewart-Williams, 2018). But this preference for economic resources in short-term mating might be related to context-specific traits as when women meet a potential mate with higher socioeconomic status than their current partner (Greiling & Buss, 2000) or when the environment is high in resources (Thomas & Stewart-Williams, 2018). This circumstance may explain why, in a general context, economic resources seem to be related to long-term mating orientation in men but not to short-term mating orientation.

As important as resources are for women who seek long-term relationships, there are personality features that signal a willingness to allocate them to one partner and their offspring over a significant period (Buss, 2018; Webb & Fisher, 2018; Zinck et al., 2021). In this regard, parenthood dispositions denote the willingness to invest in offspring and it is considered a component of men's mate value which is especially relevant to attract partners for long-term relationships (Fisher et al., 2008). Accordingly, we expected that parenthood dispositions would moderate the effect of resources in the expression of long-term mating orientation in men. However, our results did not support this prediction, suggesting that socioeconomic status influences long-term mating orientation independently of parenthood dispositions. Since socioeconomic status and parenthood disposition were correlated in this study, we explored the possibility that parenthood disposition was mediating the relationship between socioeconomic status and long-term mating orientation. We found that indeed this was the case, suggesting that socioeconomic status affects long-term mating orientation throughout an increase in parenthood disposition. Future studies are needed to confirm that result due to its exploratory nature in this study.

Our second specific prediction was focused on testing the effect of protection skills on long and short-term mating orientation. In this regard, previous literature did not find an association between protection skills (i.e. strength and muscularity) and long-term sociosexual orientation, but it did for short-term (Lukaszewski et al., 2014; Polo et al., 2019). We proposed that this feature might have a positive

effect on long-term mating orientation when interacting with other variables relevant for this context, like socioeconomic status and parenthood dispositions, and a direct and positive effect on short-term mating orientation. In line with previous research (Lukaszewski et al., 2014), strength predicted short-term but not long-term sociosexual orientation in men. However, contrary to our prediction, we did not find an effect for the proposed interaction between strength, socioeconomic status, and parenthood disposition. Thus, our results suggest that protection skills, measured from handgrip strength, do not seem to be a relevant factor that calibrates men's long-term sociosexual orientation despite being described as relevant for women when choosing a long-term partner (Buss & Schmitt, 2019). A possible explanation is that, since it has been documented that protection skills are attractive for women in both mating contexts, men who display these traits may be attracting a larger pool of women and may gain more by pursuing a short-term mating strategy, maximizing the number of sexual partners (Frederick & Haselton, 2007; Hughes & Gallup, 2003; Lukaszewski et al., 2014; Polo et al., 2019). That can be particularly true in the case of men around their reproductive peak, as is the case of our sample, which was composed of young men with an average age of 22 years old. Finally, it is interesting to emphasize that strength is positively related to short-term mating orientation and has a null, but not negative, effect in the expression of long-term mating orientation. Strength has been associated with the possession of good genes and the ability to win a conflict (Sell et al., 2009), traits that are beneficial when pursuing a short-term

mating strategy (Gangestad & Simpson, 2000). Consequently, it seems to be an important factor in calibrating short-term mating orientation but, according to our results, it did not affect long-term mating orientation. That suggests that a long-term mating orientation is not necessarily an alternative strategy employed when individuals cannot maximize their reproductive success through investing in casual sexual encounters. In addition, our results suggest that pursuing a short-term mating orientation by stronger men does not affect their orientation toward long-term mating and stress the importance of considering sociosexual orientation as a multidimensional construct.

To sum up, our results suggest that long-term-oriented men only display some of the traits that women prefer in them for long-term mating contexts, since resources but not protective skills are important for men's long-term sociosexual orientation. Previous results showed that most of the traits preferred by women for short-term relationships are important in calibrating the expression of short-term mating orientation in men (Lukaszewski et al., 2014; Polo et al., 2019; Valentine et al., 2014). However, our results are less clear about the link between traits preferred for long-term mating and the expression of long-term mating orientation in men. This may indicate that, at least some individuals who possess traits reported to be attractive for long-term relationships, may be pursuing a short-term mating strategy instead. Possibly, this reflects the overall conflict of interests between mating strategies among the sexes that arise from differences in parental investment and potential reproductive rates (Parker, 2006; Trivers, 1972).

Future studies may also include complementary theoretical approaches such as life history theory to study reproductive trade-offs in humans (Kruger, 2017). From this framework, one of the variables that has been reported to affect sociosexual orientation in adulthood is developmental conditions and, especially, the predictability and hardness of the childhood environment (Ellis et al., 2009). Considering these developmental conditions jointly with current traits and conditions may help to have a wider understanding of the causes of the individual differences in mating strategies.

Our study has several limitations. First, our measure of parenthood dispositions which, although based on a subscale of a validated questionnaire (Fisher et al., 2008), might be too general as it was composed of only two items and precluded delving into different sources of investment and commitment to offspring. Future studies should include more specific measures of parenthood dispositions to determine whether different types of investment in offspring influence the relationships between socioeconomic status and long-term mating orientation in different ways. Second, our sample mainly consisted of young men and with low variability in age. This precludes analyzing whether the association of traits and mating strategies changes as individuals age and consolidate their social status. Future studies should include a wider age range to address this issue, either by pursuing a larger sample or by quota sampling by age groups. Our third limitation is that we did not have information about whether the participants currently have children or not. Despite that our sample was composed mainly of young men, their

paternal status may be relevant as there is some evidence suggesting that unrestricted sociosexuality is reduced during parenthood in men, but only in those that reside with their children (Gettler et al., 2019).

In conclusion, this study found that resources are a relevant trait related to the expression of long-term sociosexual orientation in young men but not for the expression of short-term sociosexual orientation. The effect of resources over long-term mating orientation is probably mediated but not moderated by parenthood dispositions. In contrast, protection skills are important traits only concerning short-term sociosexual orientation. Finally, this study not only provides evidence of the features exhibited by men regarding long-term mating orientation in a Latin American context but also stresses the importance of considering sociosexual orientation as a multidimensional construct to better understand the complexity of human mating.

Study 2: Hormonal underpinnings in men's mating strategies: the role of exogenous testosterone in shaping mating strategies

Introduction

The previous study addressed evolutionary explanations for diversity in human sociosexuality. However, proximate mechanisms are also important to explain how mating strategies are calibrated between and within individuals according to contextual factors. Concretely, and following previous studies, we propose that testosterone has effects on mating strategies and on different mechanisms of social status acquisition, and at the same time mating strategies and status acquisition are related to each other, especially in men (Archer, 2006; Eisenegger et al., 2011; Von Rueden et al., 2011; Zilioli & Bird, 2017).

Testosterone is a steroid hormone that is thought to play an important role as a social hormone affecting reproductive strategies, mating efforts, and status-seeking behaviors in many vertebrates, including humans (Gray et al., 2020; Grebe et al., 2019; Wingfield et al., 2020). In humans, and especially in men, testosterone is suggested to affect the trade-off between mating and parenting (Gangestad & Simpson, 2000). In this regard, high testosterone levels are expected to promote mating effort and social behaviors, such as aggression, related to the gain and maintenance of social status (Archer, 2006). Conversely, there is evidence that shows that testosterone levels are low in men involved in committed relationships, especially in recent fathers, presumably to promote

parental investment and offspring survival (Burnham et al., 2003; Gettler et al., 2011, 2019; Gray et al., 2020). However, levels remain high when men involved in a relationship show interest in maintaining extra-couple intercourse (Edelstein et al., 2011; McIntyre et al., 2006). This evidence suggests that testosterone may affect reproductive strategies changing the psychological attitudes toward investing in mating or parenting according to the context. However, both the causal relationship and the behavioral consequences –related to status acquisition—between levels of testosterone and changes in attitudes toward investing in mating or parenting are still debated.

Sociosexuality, understood as the individual predisposition to get involved in a sexual relationship with different degrees of commitment, is a measure that has been used to assess the relative investment of individuals in mating and parenting (Gangestad & Simpson, 2000; Jackson & Kirkpatrick, 2007; Simpson & Gangestad, 1991). Accordingly, it has been argued that testosterone regulates the expression of sociosexuality, especially the expression of its attitudinal dimension (Gangestad & Simpson, 2000; Jackson & Kirkpatrick, 2007), but the empirical evidence of this relationship is mixed (e. g. Kordsmeyer et al., 2018; Puts et al., 2015; Stern et al., 2020). Puts and colleagues (2015) found that basal levels of testosterone were positively related to levels of sociosexual attitudes and desires in men but not in women. They also found that this effect is regulated through the actual success in acquiring multiple mates, showing negative feedback. However, Stern and colleagues (2020) were not able to replicate the

results of Puts et al. (2015) in a longitudinal study. Moreover, in a cross-sectional study, they found that levels of testosterone were positively linked to unrestricted sociosexuality, only when levels of cortisol were low (Stern et al., 2020). Finally, other studies failed to find any relationship between basal levels of testosterone and sociosexuality (Charles & Alexander, 2011; Farrelly et al., 2015; Kordsmeyer et al., 2018; van Anders et al., 2007).

Since testosterone effects on sociosexual attitudes and behaviors have negative feedback regulating the levels of basal testosterone (Puts et al., 2015), correlational studies may fail to find a relationship between testosterone and sociosexuality. Thus, experimental designs may be more appropriate to study that relationship. In this regard, the exogenous administration of a single dose of testosterone has been used to study causal relationships between levels of testosterone and several behavioral and psychological processes (reviewed in Carré & Robinson, 2020). However, there is a lack of studies investigating whether experimental changes in testosterone are related to changes in sociosexuality in men. In addition, developmental levels of testosterone, measured through muscularity and strength, affects sociosexual attitudes (Lukaszewski et al., 2014; Polo et al., 2019) and may moderate the effects of circulating levels over sociosexuality, indicating the need of considering them when analyzing the effect of circulating levels of testosterone on sociosexuality.

Testosterone is also a hormone linked to status-seeking behaviors in nonhumans and humans (Archer, 2006; Eisenegger et al., 2011; Wingfield et al., 1990). In humans, status may be acquired by two pathways: dominance and prestige. Whereas dominance is based on intimidation and the use of threat to gain resources, prestige is based on the ability to confer benefits to others (e.g., knowledge) to gain access to other resources (Cheng et al., 2013; Henrich & Gil-White, 2001). According to the social status hypothesis, testosterone would be related to both pathways (Eisenegger et al., 2010), but only the link between testosterone and dominance is relatively well supported by the evidence (e.g. Archer, 2006; Mazur & Booth, 1998), meanwhile the relationship between testosterone and prestige is less clear. Testosterone levels have been positively linked to aggression, especially in competitive contexts or in response to mating cues (Archer, 2006; Geniole et al., 2020; Geniole & Carré, 2019). Nevertheless, the evidence of the causal effect of testosterone in promoting aggression is discussed (Geniole et al., 2020) and seems to be dependent upon certain personality traits such as dominance and impulsivity (Carré et al., 2017). Testosterone is also linked to dominant and risk-taking behaviors (Slatcher et al., 2011) and recent studies employing exogenous testosterone found that this hormone influences the self-perception of dominance (Welling et al., 2016) and decreases the perception of third parties' dominance (Han et al., 2021). All this evidence suggests that testosterone may play an important role in acquiring status through dominance in a context that promotes competition for resources,

including mating opportunities and in interaction with traits denoting intrasexual competition capabilities. However, the link between testosterone and prestige is less clear, as some studies found that prestige and prosocial behaviors were inversely linked to testosterone levels and inversely or not related to aggression (Harris et al., 1996; Johnson et al., 2007). Conversely, another study indicates that achieving high status through prestige raises testosterone in the following months in men but not in women, indicating that past experiences of prestige may calibrate future investment in seeking and maintaining status through prestige (Cheng et al., 2018). Finally, there are studies employing exogenous testosterone supporting the social status hypothesis (Boksem et al., 2013; Eisenegger et al., 2010; Van Honk et al., 2012). However, these experimental studies are based on women's behavior, so studies in men considering both levels of testosterone (i.e., circulating and developmental) are relevant to shed light on the role of testosterone in status-seeking by prestige.

Past studies investigated how testosterone is linked to both sociosexuality and status-seeking behaviors but did not integrate them. In this regard, given the evidence that the effect of testosterone on status-seeking behaviors may be dependent on personality traits (Carré et al., 2017), sociosexual attitudes may represent a relevant variable affecting the pursuit of social status by dominance and prestige. In this regard, short-term sociosexual attitudes are reported to be positively associated with the presence of traits relevant in intrasexual competition and in acquiring status through dominance like musculature, strength, or facial

masculinity (Arnocky et al., 2018; Hughes & Gallup, 2003; Lukaszewski et al., 2014; Polo et al., 2019). However, the link between sociosexual attitudes and prestigious behaviors is less explored, and indirect evidence point toward an opposite pattern. For instance, unrestricted sociosexuality (short-term sociosexual attitudes) is linked to coercive resource acquisition but unrelated to prosocial resource acquisition (Chen et al., 2017). Therefore, more studies are needed to investigate how mating strategies can affect the relationship between testosterone and status-seeking behaviors.

In addition to testosterone levels, the social context may play an important role in calibrating sociosexuality and status-seeking behaviors. First, the presence of potential mates increases sociosexual attitudes and desires in men (Arnocky et al., 2016). In addition, mate availability influences intrasexual competition and the display of risky behaviors that can be related to status-seeking behaviors in the presence of a women audience (Arnocky et al., 2014). Finally, social interaction with women is related to changes in testosterone levels in heterosexual men that, in turn, may affect sociosexual attitudes and status-seeking behaviors (Roney et al., 2007). Therefore, the presence or absence of women is a relevant element to understand the effect of testosterone on sociosexuality and status-seeking behaviors in men.

This study has three major goals. First, we aimed to test whether changes in testosterone levels are causally linked to changes in sociosexuality and status-

seeking behaviors in young men. Second, we investigated whether differences in sociosexuality have behavioral consequences related to status acquisition and if this relationship is enhanced when levels of testosterone are increased. And finally, we investigated whether the presence of a confederate woman increases short-term mating attitudes and enhanced status-seeking behaviors compared with the absence of her. To address these goals, we employed a double-blind, placebo-controlled within-individual design in two contexts: the presence of a woman or a man confederate. In this regard, we set up four sets of predictions. First, if levels of testosterone have a direct effect on mating strategies in men, we expect that individuals treated with a single dose of testosterone would report a higher short-term mating orientation and lower long-term mating orientation compared to when they are treated with a placebo gel, considering as potential moderators the morphological traits denoting intrasexual competitive abilities. Second, according to the social status hypothesis, we expect that individuals treated with a single dose of testosterone would behave more aggressively in a context in which social status can be achieved through dominance but they would behave more cooperative when social status can be achieved through prestige, considering as potential moderators the morphological traits denoting intrasexual competitive abilities. Third, we expect to find a positive association between short-term sociosexual attitudes and both dominance and prestigious behaviors in contexts in which status is at stake. This relationship would be enhanced in individuals treated with a single dose of testosterone compared with the placebo

condition. And fourth, if the presence of evolutionary relevant variables affects the expression of mating strategies, we expect that the presence of a woman confederate would increase the short-term mating orientation, compared to the presence of a man confederate, both in the placebo and testosterone condition.

Methodology

Participants

Our sample consisted of 104 heterosexual and bisexual men aged 18 to 36 (M = 23.13, S.D. = 3.26) that participated in any of the phases of the study. In the first phase, 99 individuals participated but 95 attended both sessions (placebo and testosterone). From these 95 individuals, 38 participated in the second phase of the study, and 34 attended both sessions. Only 5 individuals participated just in the second phase of the study. We have recruited participants through announcements on the laboratory and institutional webpages, and announcements in social media and public places. Our participants were mostly, but not exclusively, college students from the Region of Valparaíso (Chile). We targeted men from 18 to 39 years because during this age intrasexual competition and the struggle for status are more intense (see Wilson & Daly, 1985). Participants received 5000 Chilean pesos (approx 7 USD) for showing up, and a variable amount of up to 15000 Chilean pesos (approx 21 USD) based on their performance in the economic games. The data was collected in 2019.

Study design

We employed a double-blind, placebo-controlled within-individual design. Therefore, both individuals and research members that interacted with participants were unaware of which treatment condition participants were exposed to. There were two counterbalanced conditions: one in which participants were administered a single dose of 150mg of testosterone gel, and another in which they were administered 150mg of placebo gel. The experimental design considered two main stages. In the first stage, we read and asked to sign the informed consent, responded to participants' questions, and set up groups of 5 men and 1 confederate woman. Each group was tested in the two mentioned conditions. Participants were asked whether they believe that they received testosterone or a placebo at the end of the protocol in both conditions, since participants' beliefs about the treatment may influence their behavior (Eisenegger et al., 2010). In the second stage, we recruited former participants to set up groups of 5 men and 1 confederate man and performed the same protocol as in the first stage. The inclusion of a woman confederate was to create a context of enhanced intrasexual competition among participants. Meanwhile, the man confederate was included as control and to keep group size constant among stages. Regardless of group composition, individuals always played against same-sex peers. At the beginning of each experimental session, testosterone or placebo was provided to participants that were instructed in how to apply the drug. After three hours of the testosterone (or placebo) administration, a first saliva sample was collected and

participants completed a quick sociodemographic questionnaire and the multidimensional sociosexual orientation inventory. Next, a Public Good Game (7 minutes) and Point Subtraction Aggression Paradigm (10 minutes) were played, and a second saliva sample was collected just after the games. The two experimental paradigms were counterbalanced among groups but games were played in the same order. Confederate woman and men participated in the PGG with a fixed quantity of 1.500 Chilean pesos.

Psychometric measures

Sociodemographic questionnaire: Participants answered a general sociodemographic questionnaire with questions about their age, relationship status (single or paired), months in the relationship (if they are paired), socioeconomic status, origin, sexual orientation, educational level, and sex.

Multidimensional Sociosexual Orientation Inventory (SOI). Participants completed a Chilean adaptation of the multidimensional sociosexual orientation inventory (Jackson & Kirkpatrick, 2007). This questionnaire is composed of 22 items and it is based on a three-factor model comprising: a short-term mating orientation (STMO) scale composed by 10 items, a long-term mating orientation (LTMO) scale composed by seven items, and a measure of previous sexual behavior composed by five items. The attitudinal items are responded using a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree).

Morphometric measurements

Prenatal testosterone: Digit Ratio (2D:4D). The prenatal level of testosterone can be indirectly assessed by measuring the ratio between the length of the 2nd and 4th digits (Manning, 2002). Lower digit ratios indicate higher levels of prenatal testosterone, being the measure from the right hand a more accurate assessment (Manning, 2002). Measurements were obtained from the length of the 2nd and 4th fingers from the basal crease of the finger to the tip, using a high precision digital caliper (Insize© 1102-150) with a precision of ± 0.01 cm.

Pubertal testosterone: Strength. Hand grip strength (HGS) is a widely used measure of upper-body strength, which in turn correlates with fighting ability (Muñoz-Reyes et al., 2012; Sell et al., 2012). It was estimated from a hydraulic hand grip dynamometer (Jamar® 5030J1) following Gallup et al. (2007), and Muñoz-Reyes et al. (2012) protocol. Measurements were recorded in three alternating trials for each hand. The maximum HGS (of both hands) was used in the analyses.

Body mass index (BMI). This is a measure that covariates with strength and muscle mass and, accordingly, it is convenient to control its effect on them when studying strength and muscle mass relationships with other traits. The participants' weight was measured using a digital body scale and their height was obtained using a stadiometer, in order to calculate BMI. This was measured as in Study 1 (see Measures).

Muscle composition. Skeletal muscle mass (kg), was assessed with a body composition analyzer (Inbody 370). This device employs a tetrapolar 8-point tactile electrode for measurements through a direct segmental multifrequency bioelectrical impedance analysis method (DSM-BIA). The DSM-BIA is a valid tool for the assessment of total and segmental body composition (Ling et al., 2011).

Behavioral measurements

Aggressive measurement. The Point Subtraction Aggression Paradigm (PSAP). This computer game was first performed in the 80s by Cherek (1981) and it is a highly reliable tool to estimate aggression, especially in men (Geniole et al., 2017). The objective of the game is to win as many points as they can, which will later be exchanged for real money. Participants play against a fictional opponent and have three button-operated options, that cannot be performed at the same time: a) Gaining points by pressing consecutively 100 times the button A. b) Aggression: Participants can subtract points from the other participant by pressing 10 times the button B. Points are not added to their personal account. c) Protection: participants can prevent losing points by pressing the button C 10 times. We applied a similar protocol performed by Carré and McCormick (2008) but with one round of 10 minutes. Regardless of the composition of the experimental group (same-sex or mixed-sex), participants were told that they were going to play with a same-sex opponent, without knowing his identity. It is relevant to note that to give more ecological validity and to take into account the relevance of aggression for intragroup status, we followed the strategy used by

Geniole et al. (2017). In this version, men were intensively attacked (i.e., points were subtracted to them frequently), as an indirect measure of status loss.

Cooperative measurement. Public good game (PGG). In this game, individuals have an initial amount of money. They can choose to invest all, some part, or nothing of this money in a common pool. Once all the participants have made their choices, the common pool will be multiplied by 2 and the total amount will be equally distributed among all participants regardless of their contribution. Therefore, this game is a social dilemma in which individuals face a trade-off between pursuing a cooperative or a selfish outcome (Ostrom, 2001). Participants played three rounds of this game and at the end of each round researchers announced the person who had contributed the most. Thus, we aimed to create a context in which participants may compete for being the most cooperative in the group and therefore gain prestige among group members. All participants started each round with 3.000 Chilean pesos. The public good game was played on computers and, although individuals were not able to observe or know others' contributions, the identities were known (i.e. non-anonymous game).

Measure of circulating Testosterone

This was measured following the protocol used by Sanchez-Pages and Turiegano (2010), and complemented by Mehta et al. (2015). Two samples of circulating testosterone were obtained from saliva provided by subjects in the study. Participants were asked not to drink or eat anything apart from water one hour before the study starts. At the beginning of the experimental session, participants

were asked to spit through a straw into a saliva sampling device (Sali-tubes 100, DRG). At the end of the experimental process, participants were asked to provide a second saliva sample. A lack of delay between the experimental procedure and the second testosterone measure will allow us to capture the effect of the social interaction on circulating testosterone levels, separated from the effect of winning or losing the interaction, as prior studies have demonstrated that the hormonal and psychological effects derived from winning or losing a competition are delayed 15-20 minutes (Casto & Edwards, 2016). Saliva samples were immediately centrifuged, frozen, and stored at−20 °C. All samples were analyzed employing Testosterone Enzyme Immunoassay Kits (Salivary testosterone ELISA kit from Biocant Ltda.) following the manufacturer's instructions. Results from ELISA assays showed abnormally high values of testosterone concentrations. Most of the results were outside the calibration curve and when extrapolated showed very high values. The analyses were repeated several times using dilutions, but the results did not improve. We suspect that the kits used were damaged due to loss of the cold chain. For this reason, we were not able to use the circulating testosterone data in this study.

Data analysis

We performed different hierarchical linear models analyses to address each proposed hypotheses, considering within-subject measures as level-1, and between-subject measures as level-2 measures. For the first hypothesis, we fitted two hierarchical linear models. For the first model (model 1.1), the dependent

variable was the short-term mating orientation (STMO), which is a level-1 variable since it is measured in two conditions (placebo and treatment) for each subject. Our independent variables were the experimental condition (level-1 variable), and three level-2 variables: 2D:4D digit ratio, strength, and muscle mass. We analyzed the interactions between the experimental condition and the other predictor variables. As control variables, we considered age, body mass index, relationship status (single or paired) and order of treatment (level-2 variables), and the response to the question about the treatment (level-1 variable). For the second model (model 1.2), the dependent variable was the long-term mating orientation (LTMO), which is a level-1 variable since LTMO is also measured in two conditions (placebo and treatment) for each subject. Predictors and control variables, as well as the two-way interactions, were the same as in model 1.1. To test the second hypothesis, we fitted three hierarchical linear models. For the first one (model 2.1), the dependent variable was the aggressive behavior displayed in the Point Subtraction Aggression Paradigm, calculated as the number of times the individual pressed the attack button as a proportion of the total number of button-pressing. This is a level-1 variable since aggression is also measured in two conditions (placebo and treatment) for each subject. Our predictors and control variables were the same as in model 1.1. In the second model (model 2.2), the dependent variable was the variation in the amount of money donated in the public good game between the first and third round. Predictors, control variables, and interactions were the same as in model 2.1. In the third model (model 2.3),

the dependent variable was the amount of money donated in the third round of the public good game. Predictors, control variables, and interactions were the same as in models 2.1 and 2.2. For our third hypothesis, we added as a predictor variable STMO and the interaction between STMO and condition to models 2.1, 2.2, and 2.3. Finally, to test our fourth hypothesis, we fitted one hierarchical linear model. For this model (4.1), the dependent variable was the STMO (level-1 variable). Our predictor variables were the condition (placebo vs. treatment, level-1 variable) and the context (presence of a woman or a man confederate, also level-1 variable). As control variables, we considered the same as in models fitted for the first and second hypotheses. Before performing the analyses, we standardized all the variables and tested if there is collinearity in our predictor variables. We used data from the first stage of the study (N = 99), i.e., when participants played with a woman confederate, to test hypothesis one, two, and three. These three hypotheses do not consider the group composition as a factor. To test our fourth hypothesis, we used data from the two stages of our study (N = 43), i.e., when participants played with a woman confederate in the first stage and with a man confederate in the second. We decided to employ hierarchical linear models to deal with the repeated measures of the data, and specified maximum likelihood estimation (ML) and Type III variance in all the models. Individual ID was included as the random effect in all of our models.

Results

Table 4 shows descriptive statistics for level-1 and level-2 variables across treatments and confederates' condition (presence of a woman or a man).

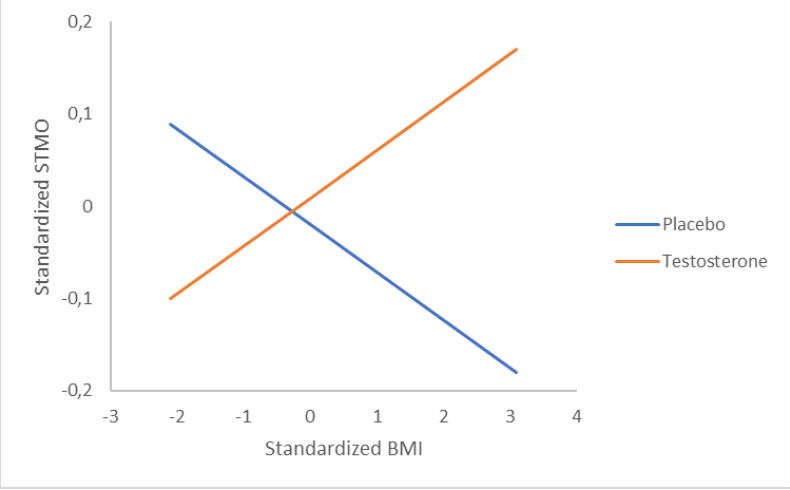
Table 4: Mean and standard deviation of each variable used in the models

		Mean (Std. Deviation)			
		Stage 1 (N = 194)		Stage 2 (N = 81)	
		Control (N = 99)	Treatment (N = 95)	Control (N = 38)	Treatment (N = 43)
Sociosexual orientation	Short-term	4.87 (1.30)	4.93 (1.25)	4.51 (1.00)	4.51 (1.01)
	Long-term	5.08 (1.26)	5.01 (1.24)	4.50 (0.83)	4.57 (0.84)
Contribution in PGG (in CLP)	Round 1	1189 (463)	1224 (445)	1310 (360)	1410 (216)
	Round 3	1207 (550)	1129 (560)	1158 (562)	1309 (391)
Attacks in PSAP		12.7 (18.6)	10.7 (16.8)	5.55 (9.53)	13.2 (39.1)
Muscle mass (in kg)		32.34 (4.01)		31.84 (4.37)	
BMI		24.05 (2.88)		23.11 (2.79)	
Age (in years)		23.10 (3.27)		22.85 (2.82)	

Regarding our first prediction (Table 6), we did not find any effect of treatment neither as a main effect ($F_{1,96.591} = .311$, $p = .562$) nor in interaction with muscle mass ($F_{1,95.171} = .047$, $p = 829$) or 2D:4D digit ratio ($F_{1,95.168} = .449$, $p = .505$) on the expression of short-term mating orientation. We only found an interaction effect between treatment and BMI ($F_{1,94.949} = 6.580$, $p = .012$). As this interaction was the only significant effect in the model, and in order to interpret it, we fitted a reduced model only containing the interaction. We found that BMI was negatively related to short-term mating orientation in the placebo condition, but positively related in the testosterone condition (Figure 1). To interpret this result considering

the repeated measures, we divided BMI into three categories representing individuals in the lower third, in the intermedium third and in the higher third of the BMI range. Results from t-tests for repeated measures for each category showed that the administration of testosterone increased the expression of short-term mating orientation in men in the higher third of the BMI range (t = 2.140, df = 31, p = .040) but no differences were found in the lower third (t = -1.731, df = 30, p = .094) or in the intermedium third (t = 1.016, df = 31, p = .318). Regarding long-term mating orientation, we did not find any effect of treatment neither as a main effect ($F_{1,96.224}$ = 1.031, p = .313) nor in interaction with muscle mass ($F_{1,94.447}$ = .016, p = .899) or 2D:4D digit ratio ($F_{1,94.749}$ = 1.221, p = .272). However, we found significant effects of relationship status and age. Single individuals showed lower long-term mating orientation than paired individuals (β_{single} = -.3954; t = -2.388; p = .018), whereas age was positively related to long-term mating orientation (β = .2060; t = 2.179; p = .032).

Figure 1: Predicted values for standardized Short-term mating orientation (STMO)



Regarding our second hypothesis (Table 5), we did not find a main effect of treatment on the difference of contributions in the public good game ($F_{1,98.446}$ = 1.892, p = .172), but we found a significant interaction between treatment and muscle mass ($F_{1,95.739}$ = 5.216, p = .025). As this interaction term was the only significant effect in the model, and in order to interpret it, we fitted a reduced model only containing the interaction. We found that muscle mass was negatively related to the difference in contributions in the testosterone treatment but positively related to differences in contributions in the placebo treatment (Figure 2). In order to interpret this result considering the repeated measures, we divided muscle mass into three categories representing individuals in the lower third, in the intermedium third and in the higher third of the muscle mass range. Results from t-tests for repeated measures for each category showed that the administration of testosterone reduces the differences of contributions between the third and first round in men in the higher third of the muscle mass but the differences were not significant (t = -1.730, df = 31, p = .094). However, if we consider only contributions in the final round, we did not find any effect of treatment neither as a main effect ($F_{1,98.635}$ = 1.133, p = .290) nor in interaction with muscle mass ($F_{1,96.081}$ = 1.740, p = .190) or 2D:4D digit ratio ($F_{1,97.113}$ = .376, p = .541). In addition, none of the control variables had a significant effect. In regard to aggression in the PSAP, we did not find any effect of treatment neither as a main effect ($F_{1,96.968}$ = .959, p = .330) nor in interaction with muscle mass ($F_{1,93.439}$ = 2.109, p = .150) or 2D:4D digit ratio ($F_{1,94.976}$ = .486, p = .488). We only found a

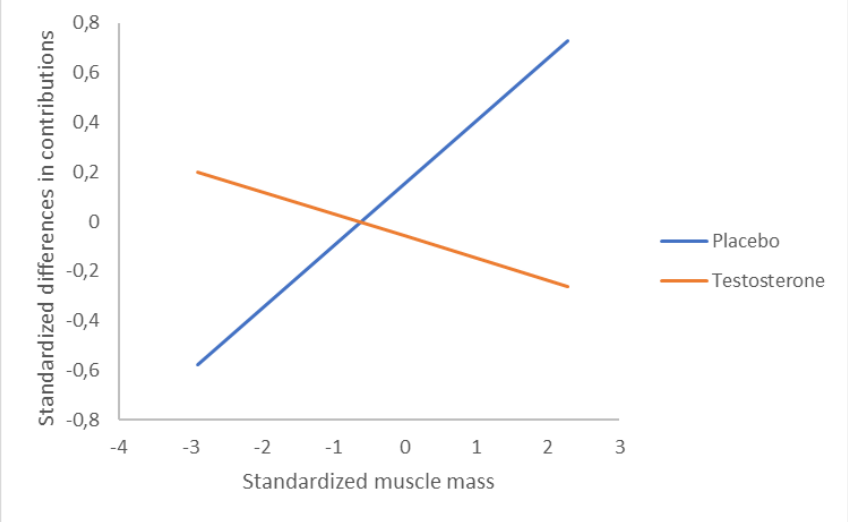
positive relationship between age and aggression in the PSAP (β = .2380; t = 2.856; p = .005).

Table 5: Linear models' coeafficients and p-values for hypothesis 2

	Differences in contribution		Contribution in last round		Aggression in PSAP	
	β	p-value	β	p-value	β	p-value
Intercept	-0.047	0.817	0.102	0.604	-0.164	0.396
Treatment= 0	0.184	0.172	0.128	0.290	0.118	0.330
Relationship Status= 0	-0.068	0.695	-0.061	0.723	0.082	0.626
Order = 0	-0.100	0.557	-0.307	0.074	0.150	0.367
Final question = 0	0.141	0.387	0.046	0.759	-0.029	0.849
BMI	0.145	0.234	0.126	0.286	-0.093	0.429
Muscle mass	-0.091	0.434	-0.090	0.424	0.139	0.209
Age	-0.012	0.885	0.007	0.932	0.238	0.005
2d:4d	0.131	0.221	0.116	0.259	-0.034	0.736
Treatment= 0 * Muscle mass	0.334	0.025	0.174	0.190	-0.190	0.150
Treatment = 0 * 2d:4d	-0.075	0.574	-0.073	0.541	0.084	0.488
Treatment = 0 * BMI	-0.256	0.081	-0.221	0.094	0.182	0.171

Dependent variables, BMI, Muscle mass, and 2d:4d were z-standardized prior to fitting models

Figure 2: Predicted values for standardized differences in contribution in the Public Goods Game



In relation to our third hypothesis, we found that short-term mating orientation was not related to differences in contribution in PGG neither as a main effect ($F_{1,106.714}$ = 1.074, p = .302) or in interaction with treatment ($F_{1,100.170}$ = .000, p = .991). Similarly, short-term mating orientation was not related to contributions in the last round of the PGG neither as a main effect ($F_{1,109.280}$ = 1.120, p = .292) or in interaction with treatment ($F_{1,99.706}$ = .246, p = .621). Finally, short-term mating orientation was not related to aggression score in the PSAP neither as a main effect ($F_{1,106.259}$ = .193, p = .661) nor in interaction with treatment ($F_{1,97.002}$ = 2.014, p = .159).

Finally, regarding our fourth hypothesis (Table 6), we found that men playing with a woman confederate showed higher levels of short-term mating orientation in comparison when they played with a man confederate regardless of treatment ($F_{1,195.054}$ = 84.706, p < .001). In addition, we found that men when playing with a woman confederate also showed higher levels of long-term mating orientation compared when they played with a man confederate regardless of treatment ($F_{1,215.108}$ = 7.696, p = .006). We also found a significant effect of relationship status and age. Single men showed lower levels of long-term mating orientation than men in a relationship (β_{single} = -.310; t = -2.304; p = .022) and older men showed higher levels of long-term mating orientation (β = .192; t = 2.224; p = .028).

Table 6: Linear models' coefficients for hypotheses 1 and 4

	STMO		LTMO	
	β hyp. 1	β hyp. 4	β hyp. 1	β hyp. 4
Intercept	-0.058	-0.462**	0.277	0.075
Treatment = 0	-0.022	-0.050	0.063	0.029
Relationship Status = 0	0.067	0.032	-0.395*	-0.310*
Order = 0	0.078	0.144	0.022	0.123
Final question = 0	-0.028	-0.018	-0.131	-0.160~
Female confederate = 0	--	0.479***	--	0.226*
BMI	-0.014	-0.022	0.017	0.023
Muscle mass	0.024	0.040	-0.008	0.042
Age	0.175	0.166	0.206*	0.192*
2d:4d	0.010	0.018	-0.111	-0.143
Treatment = 0 * Muscle mass	-0.009	-0.004	0.009	0.020
Treatment = 0 * 2d:4d	0.025	0.017	-0.067	-0.044
Treatment = 0 * BMI	-0.102*	-0.109**	0.038	0.036
Treatment = 0 * Confederate	--	0.033	--	0.043

~p<0.1; *p<0.05; **p<0.01; ***p<0.001

STMO, LTMO, BMI, Muscle mass, and 2d:4d were z-standardized prior to fitting models.

Discussion

In this study, we tested the causal role of testosterone on sociosexual attitudes and status-seeking behaviors through dominance and prestige and how social context may influence the expression of sociosexual attitudes. Our results support only one out of four of our predictions, as we did not find a clear effect of testosterone administration on short-term or long-term mating orientation. Moreover, the administration of testosterone seems to decrease cooperation in more muscular men, a result that contrasts with the social status hypothesis. However, we found the predicted effect of the social context since the presence of a woman increases men's short-term mating orientation; but surprisingly it increases long-term mating orientation as well.

Testosterone is a social hormone that plays an important role in the allocation of time and energy in mating or parental effort (Grebe et al., 2019). Thus, an increase in circulating testosterone levels should affect the predisposition to invest in mating versus parenting. Our first specific prediction stated that variation in circulating testosterone levels was causally linked to changes in sociosexual attitudes, considering that a short-term mating orientation reflects the predisposition of the individuals to invest in mating, whereas a long-term mating orientation reflects the predisposition of the individuals to invest in parenting (Jackson & Kirkpatrick, 2007; Valentova et al., 2020). Our results did not support our prediction since the administration of exogenous testosterone changed neither short-term nor long-term mating orientation in men compared to when they were administered a placebo gel. Previous studies have reported that levels of testosterone vary according to relationship status and fatherhood (Burnham et al., 2003; Gettler et al., 2011, 2019; Gray et al., 2020; Grebe et al., 2019). Moreover, these changes were moderated by sociosexual orientation (McIntyre et al., 2006) suggesting that levels of testosterone and sociosexual orientation are related. One of the possible explanations for our results is that sociosexual attitudes modulate levels of testosterone and not the other way around. In other words, social factors such as getting involved in a committed relationship or becoming a father may affect sociosexual attitudes and this may regulate circulating levels of testosterone. An alternative explanation is related to the dual-hormone hypothesis, which states that changes in testosterone are related to behavioral

responses but this relationship is moderated by cortisol levels (Mehta et al., 2015). In this regard, Stern and colleagues (2020) in a cross-sectional study found that levels of testosterone were positively associated with sociosexual orientation when levels of cortisol were low. In our study, we were not able to measure cortisol, and therefore, our results may indicate the need of considering cortisol levels in future studies in order to find a causal relationship between levels of testosterone and sociosexual attitudes. However, in a longitudinal study, Stern and colleagues (2020) did not find an association between within-subject testosterone changes and sociosexual orientation, even considering cortisol levels. The longitudinal study resembles our study more than the cross-sectional one, as we also tested within-subject testosterone changes, so maybe our null result is not a consequence of not considering cortisol.

We found that the administration of exogenous testosterone had a significate effect but in interaction with BMI, that is, individuals with high BMI showed higher short-term mating orientation when administered with testosterone compared to placebo. This result has to be interpreted with caution since BMI was only included in the model as a control variable and no specific prediction considered it. Individuals with higher BMI are in general considered less attractive than those with lower BMI as it is usually positively associated with obesity (e. g. Weeden & Sabini, 2005). Plus, both self-rated and others-rated physical attractiveness, and morphological traits that are attractive to women are positively linked to short-term mating orientation in men (Figueroa et al., 2020; Lukaszewski et al., 2014). Given

that, a possible explanation of our result is that the effect of testosterone on the sociosexual attitude is small and only significant in less attractive individuals. It would be interesting to include measures of physical attractiveness as a potential moderator in future studies to test this suggestion.

Our second hypothesis aimed to test the social status hypothesis that argues that levels of testosterone play a role in promoting status-seeking behaviors both by prestige and dominance in contexts in which the status is challenged (Eisenegger et al., 2011). Our result did not support this hypothesis. First, in the case of status acquisition by dominance, we did not find any effect of the treatment on the aggression score in the PSAP. In our design, individuals were highly provoked, that is, they received a high rate of aggression from the (virtual) opponent. We assume that this could be interpreted as a challenge for the status and that individuals administered with testosterone should show higher rates of aggression. There is evidence that testosterone increases in response to competitive contexts: it is positively associated with costly aggression in the PSAP in individuals that lost the competition, as well as in dominant winners (Carré et al., 2009). In our study, changes in testosterone were artificially induced, suggesting that increased levels of testosterone may be necessary but not enough to provoke aggression in the individuals. In this regard, contextual and individual factors, like the presence of a previous competition or impulsivity may be necessary to elicit the dominant behavior (Carré et al., 2017). In addition, levels of cortisol may be playing a role in the effect of testosterone on aggressive

behavior (Sarkar et al., 2018). In the case of prestige, our results are opposed as expected since we found that more muscular men tend to decrease their donations from the first game to the third game when they were administered with exogenous testosterone. There is previous evidence showing that the exogenous administration of testosterone has a positive association with cooperative choices in prisoner's dilemma and public good games (Boksem et al., 2013; Eisenegger et al., 2010; Van Honk et al., 2012). However, these studies have two important differences. First, they were between-subjects' designs, and second and more important, the participants were women. To our knowledge, this is the first study to test whether exogenous testosterone is associated with cooperative behavior in the public good game in men. We failed to find a positive association suggesting that maybe there are sexual differences in the association of prestigious behaviors and testosterone. Our result is also in contrast to that of Cheng and colleagues (2018), that found that gains of status by prestige are associated with an increase in testosterone levels that may predispose to maintain that prestigious status in future interactions. However, similarly to dominance, in our study the increase of testosterone levels occurs without a specific context and that may be crucial for the association of testosterone with prestigious behaviors. More studies are needed to test whether there are sex differences in the social status hypothesis and to test the relevance of contextual factors.

In our third hypothesis, we aimed to test whether short-term mating orientation was associated with status-seeking behaviors. According to the strategic

pluralism hypothesis, men oriented towards short-term mating should display features related to good genes and competitive abilities (Gangestad & Simpson, 2000). Therefore, it is plausible to argue that short-term mating individuals may seek status at least throughout dominance. Despite individuals oriented toward short-term mating show traits related to formidability like higher strength or muscular mass (Fajardo et al., 2022; Lukaszewski et al., 2014; Polo et al., 2019), our result failed to find a relationship between short-term mating orientation and dominance behavior in the PSAP. In addition, short-term mating orientation was not associated with the contributions in the public goods game. These results suggest that individuals oriented toward short-term mating are not preferentially searching for status neither through dominance or prestige. Acquiring a maintaining a high social status is an important factor that impacts reproductive success (e. g. Hopcroft, 2006) and it is probably important for individuals oriented to long or short-term mating. In this study, we treated short and long-term mating orientation as two independent dimensions but maybe it would be useful to create profiles of individuals combining both dimensions, in order to better appreciate the relationships between mating strategies and status-seeking behaviors. For instance, individuals high in both short and long-term orientation may behave more dominant and prestigious than individuals low in these two dimensions.

Finally, for our fourth prediction, we tested the influence of the presence of a woman on sociosexual attitudes and status-seeking behavior. As expected, we found that men reported higher levels of short-term mating orientation when there

was a woman in the group compared to when there was a man, regardless of the treatment. These results are in line with a previous study showing that the presence of potential mates increases sociosexual attitudes and desires in men (Arnocky et al., 2016). In addition, we found that long-term mating orientation was also increased in the presence of a woman in the group compared to the presence of a man. This is an unexpected result since the confederate woman was a stranger to the participants and therefore, we expected a variation in the motivation to seek uncommitted relationships (i.e., short-term mating orientation). However, the use of a multidimensional sociosexual inventory that considers short and long-term mating orientation as different dimensions (Jackson & Kirkpatrick, 2007) allows us to show that both dimensions are affected by the presence of a woman. Previous evidence employed a single-dimension sociosexual questionnaire that considers short and long-term mating orientation as the extreme poles of a continuum. Therefore, increases in sociosexual attitudes entail an increase in short-term and a decrease in long-term mating orientation (Arnocky et al., 2016). Thus, our results suggest that the presence of a potential partner increase mating effort both oriented toward short-term and long-term relationships.

This study has two important limitations. First, we lack of reliable measures of circulating testosterone due to a malfunction of the testosterone test kits, so we cannot quantitatively show the changes that the testosterone gel produced in hormone levels compared to the levels after placebo administration. However, we

followed the administration protocol and waiting time described in previous studies in which administration using that protocol was seen to increase circulating testosterone levels (Carré et al., 2015). And second, due to design limitation we were not able to measure cortisol. Previous studies suggest that levels of cortisol are important in order to detect behavioral responses caused by changes in testosterone levels (Mehta et al., 2015).

In conclusion in this study, we found only circumstantial evidence about the role of testosterone in calibrating sociosexual attitudes. However, the presence of a woman in the group increases sociosexual attitudes both in the short and long term. That suggests that sociosexual attitudes may be expressed flexibly but that social factors are more important than hormonal factors in this expression. We did not find evidence for the social status hypothesis suggesting that the link between changes in testosterone and status-seeking behaviors may be dependent on the specific context that provoke the hormonal change.

General Discussion

This work was focused on men's mating strategies due to the relevance of the reproductive trade-off between mating and parenting they face in our species. This research brings together approaches from the ultimate and proximal causes to better understanding of human sociosexuality. In the first study, we aimed to investigate the traits associated with men's predisposition to invest in long-term mating to understand the selective pressures that shape the cost-benefit balance

that favors men's parental investing. Therefore, we focused on evolutionary explanations and stressed the long-term orientation, clarifying the traits that influence this less investigated dimension of mating. In the second study, we investigated testosterone-related and social mechanisms involved in long and short-term mating in men. Thus, it was focused on proximate mechanisms, exploring experimentally the effect of testosterone on mating strategies and social status-seeking behaviors, as well as the link between mating strategies and social status acquisition pathways, and the relevance of the immediate social context to explain both variables.

Evolutionary factors refer to phenotypical, social and environmental factors that shape different costs and benefits in pursuing different reproductive strategies. A set of traits we predicted to influence the expression of men's mating strategies were physical features since some of them are associated with good health, "good genes", and competitive abilities (Gangestad & Simpson, 2000). The reason for this is that men who have this features become more attractive and requested by the opposite sex, hence influencing men's sociosexual attitudes and behavior (Figueroa et al., 2020; Little et al., 2011; Polo et al., 2019). For example, Buss and Schmitt (2019) suggest that physical traits related to fighting abilities are relevant for both short and long-term mating strategies, since being able to succeed in a fight means that he can protect his partner and offspring from external threats. In addition, we tested the link of social factors and mating strategies, specifically social status, that is thought to play an important role

(Gangestad & Simpson, 2000), especially for long-term mating (Buss, 1989; Wang et al., 2018).

Our findings indicate that physical features affect only short-term orientation, despite previous literature proposes that fighting abilities are useful to protect long-term partners and offspring from external threats. Since protection skills are attractive for women in both mating contexts, men bearing these traits may be attracting a larger pool of women and may have higher reproductive success by pursuing a short-term mating strategy (Frederick & Haselton, 2007; Hughes & Gallup, 2003; Lukaszewski et al., 2014; Polo et al., 2019). Accordingly, at least some individuals who possess traits reported to be attractive for long-term relationships, may be pursuing a short-term mating strategy instead. Possibly, this reflects the overall conflict of interests between mating strategies among the sexes that arise from differences in parental investment and potential reproductive rates (Parker, 2006; Trivers, 1972). A key finding of Study 1 is that men with high social status, a trait especially relevant for men's eligibility for long-term relationships, are in fact more long-term oriented. Lastly, our results suggest that pursuing a short-term mating orientation by stronger men does not affect their orientation toward long-term mating and stress the importance of considering sociosexual orientation as a multidimensional construct.

As a proximate mechanism, we explored the effect of testosterone on men's mating strategies, since previous literature found that it has a key role in intra-sex

differences and intra-individual flexibility, regulating the deployment of these strategies according to relevant evolutionary contextual factors (e.g. acquiring a high social status) (Gangestad & Simpson, 2000; Mazur, 1985; Wingfield et al., 1990). Our findings regarding testosterone show that it has no effect on sociosexuality or on social status acquisition, both by dominance/aggression or by prestige/cooperation. However, we found that it had a significative effect in interaction with BMI. That is, individuals with high BMI showed higher short-term mating orientation when administered with testosterone compared to placebo. Individuals with higher BMI are in general considered less attractive than those with lower BMI, so a possible explanation is that the effect of testosterone on the sociosexual attitude is small and only significant in less attractive individuals.

As mentioned before, men oriented towards short-term mating should display features related to good genes and competitive abilities (Gangestad & Simpson, 2000). Therefore, it is plausible to argue that short-term mating individuals may seek status at least throughout dominance. Despite individuals oriented toward short-term mating show traits related to formidability like higher strength or muscular mass (Fajardo et al., 2022; Lukaszewski et al., 2014; Polo et al., 2019), our result failed to find a relationship between short-term mating orientation and dominance behavior in the PSAP. One of the main thoughts that arise from this evidence is that increased levels of testosterone may be necessary but not enough for an aggressive behavior. In this regard, contextual factors such as the presence of a previous competition or individual features such as impulsivity or

self-control may be necessary to elicit the dominant behavior (Carré et al., 2017). In addition, levels of cortisol may also be playing a role in the effect of testosterone on aggressive behavior (Sarkar et al., 2018). In the case of status acquisition by prestige, our results are also opposed as expected since we found that more muscular men tend to decrease their donations from the first round to the third round of the game when they were administered with exogenous testosterone. These results suggest that individuals oriented toward short-term mating are not preferentially searching for status neither through dominance or prestige.

The most important variable in Study 2 was the presence a woman confederate, as a context of a mating opportunity. As expected, we found that men reported higher levels of short-term mating orientation when there was a woman in the group compared to when there was a man. This finding is according with a previous study showing that the presence of potential mates increases sociosexual attitudes and desires in men (Arnocky et al., 2016). However, our study has a greater ecological validity for two reasons. First, we manipulated the immediate social context of the participants, so they were in presence of an actual potential mate, while the previous study used only a priming condition to obtain their results. We also have intra-subject evidence while previous literature only compared between subjects. This allows us to have more reliable evidence about the change that subjects experience in the presence of a potential mate. In addition, we found that long-term mating orientation was also increased in the presence of a woman in the group compared to the presence of a man. This is an

unexpected result since the confederate woman was a stranger to the participants and therefore, we expected a variation in the motivation to seek uncommitted relationships (i.e., short-term mating orientation) but not a variation in seeking a committed relationship.

According to the evidence from both studies, we highlight two main individual traits relevant to the expression of sociosexuality: strength and status. The first one was measured as handgrip strength in the first study and as muscle mass in the second study, but the theoretical rationale for including this variable in our prediction was different in each study. In the first study, we predicted that strength has an explanatory role on sociosexual attitudes, direct for short-term orientation and in interaction with other variables for long-term orientation, finding supporting evidence only for short-term mating. In the second study, muscle mass was used as an indicator for testosterone levels, and was used only in interaction with the treatment, having no effect on sociosexuality. Therefore, strength is relevant for short-term mating orientation when it is considered as a fixed individual marker of potential success in a physical fight and an attractive feature for women.

Regarding social status, results were different between both studies: the first one found status is a key trait for long-term sociosexual orientated men and the other one did not find such a relationship. However, it is important to notice that the measures for social status were substantially different. The first study considered a self-reported socioeconomic measure, where individuals had to place

themselves on a scale from 1 to 10 according to their current position in society, considering their income, educational level, and employment situation. Since most participants were college students, this measure gives us general information about the individual's background, associated with his/her economic stability and wealth in his/her life history. The second study, on the other hand, measured social status with two behavioral tasks that capture different ways of social status acquisition; by dominance and by prestige. This way of addressing status captures status-seeking behaviors for a better social position in the group hierarchy, reflecting a personality-related tendency for being noticed within a group in a narrower context than in the first study (Cheng et al., 2010). Therefore, we posit that what would be associated with reproductive strategies would be the baseline socioeconomic position of individuals, which would give them higher material stability and wealth, and not necessarily the attitudes of seeking such status.

For future research, it would be relevant to investigate the features associated with short and long-term sociosexual attitudes but for a female population, also testing if they display what men expect from them for both reproductive contexts. The results would probably be different since they have faced different selective pressures and have some physiological differences that could lead them to other outcomes in terms of the reproductive trade-off (Buss & Schmitt, 2019; Trivers, 1972). Another useful element to consider in future designs, as it was suggested in the second study, is to include other complementary hormonal analyses

besides testosterone, such as cortisol samples to account for the Dual-Hormone Hypothesis (Sarkar et al., 2018; Stern et al., 2020), to explore the role of the interaction of both levels in sociosexuality and status acquisition. Lastly, since one of the results suggested the relevance of group composition in sociosexual attitudes, it would be interesting to design studies with samples that consider different group compositions by sex in more ecological environments (i.e. work or study environments). In such a design, individuals that, for example, are used to belong to a group of individuals of the same gender as them, have to participate in experimental sessions with an opposite-sex confederate.

In sum, this thesis shed light on evolutionary and proximate causes of men's variability in sociosexuality. This led us to a broader and deeper understanding of human reproductive attitudes and behaviors, using an interdisciplinary perspective and a variety of data sources, such as psychometric tests, physiological records, economic games, and behavioral tasks from a Latin-American sample.

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