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ORIGINAL PAPER

A Psychometric Evaluation of the Intrasexual Competition Scale

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Abstract
The Intrasexual Competition Scale (ICS) measures the extent to which individuals view their interaction with same-sex others in competitive terms. Although it is frequently used in studies investigating differences in mating behavior, the factor structure of the ICS has never been confirmed. Researchers have yet to use multiple-group confirmatory factor analysis to test whether the properties of the scale are equivalent between the sexes. In Study 1, we report on an investigation in which participants' responses to the ICS were submitted to exploratory factor analysis (EFA). In Study 2A, we compared the fit of one and two-factor models from the EFA as well as two additional models, using confirmatory factor analysis with an independent sample. The best fit was obtained by a two-factor solution, which reflected: (1) respondents' feelings of frustration when intrasexual competitors are better off (Inferiority Frustration), and (2) respondents' enjoyment of being better than intrasexual competitors (Superiority Enjoyment). This model achieved a high degree of measurement invariance. In Study 2B, we found the ICS had good concurrent validity via associations with sociosexuality, mating effort, and sexual behavior. Together, these analyses suggest that the ICS is a valid measure of intrasexually competitive attitudes.

Keywords Intrasexual competition · Measurement invariance · Sex differences · Aggression · Intrasexual Competition Scale

Introduction

Intrasexual competition refers to competition among members of the same sex for access to members of the opposite sex. It can vary according to the target of the action and the overtness of the act. Often, it is conceptualized as direct aggressive behavior such as acts of physical (Campbell, 1995; Wilson & Daly, 1985) and verbal aggression (e.g., Davis et al., 2017; Fernandez et al., 2014), which can function to injure, kill, or exclude same-sex competitors, and make them appear less desirable (e.g., Volk et al., 2012). Yet, other tactics employed during intrasexual competition can be more nuanced. Indirect aggression, for instance, includes perpetrator actions (e.g., rumor spreading) that conceal the intent of the aggressive act and the perpetrator's identity, thus reducing the likelihood that their victim can retaliate (Björkqvist et al., 1992; Davis et al., 2017; Fernandez et al., 2014).

Parental investment refers to investment by the parent which enhances the offspring's fitness at the cost of parents' ability to invest in future offspring (Trivers, 1972). In humans, like in other animals, parental investment shapes the qualities that males and females prefer in prospective mates, and the way in which they compete to access them. Both sexes value mates who are dependable, kind, and conscientious, because humans engage in bi-parental care to rear highly dependent offspring (Buss, 1989; Eastwick & Finkel, 2008; Li & Kenrick, 2006; Li et al., 2002). Yet, because of women's greater obligatory parental investment, they tend

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to place greater value on a mate's capability to provision them and their offspring and prefer men who possess status and economic resources (Atari et al., 2020; Buss, 1989; Castro & de Araújo Lopes, 2011; Walter et al., 2020; Zhang et al., 2019). In contrast, men tend to prefer cues of youth and fecundity, signified by physical attractiveness, because their reproductive potential is limited by access to fecund women (Atari et al., 2020; Buss, 1989; Castro & de Araújo Lopes, 2011; Perilloux et al., 2010; Walter et al., 2020; Zhang et al., 2019). Recent research would suggest that women's and men's preferences remain consistent across cultures (Atari et al., 2020; Buss, 1989; Castro & de Araújo Lopes, 2011; Walter et al., 2020) and are not significantly impacted by countries' gender equality (Zhang et al., 2019). Women compete for access to men by emphasizing cues to youth, fertility, and physical attractiveness (Bleske-Rechek & Buss, 2006; Buss, 1988; Durante et al., 2008; Hill & Durante, 2011; van Brummen–Girigori & Buunk, 2016), and experience higher levels of jealousy towards peers who are more physically attractive (Arnocky et al., 2014b; Buunk et al., 2010). Women are constrained by their access to high quality men who can provide resources to them and their offspring (Atari et al., 2020; Buss, 1989; Castro & Araújo Lopes, 2011; Eastwick & Finkel, 2008; Li & Kenrick, 2006; Li et al., 2002; Walter et al., 2020). As such, men emphasize qualities linked to resource provisioning ability such as wealth, status, and intelligence (Buss & Schmitt, 1993; Davis et al., 2017; Eastwick & Finkel, 2008), and derogate competitors' wealth, status, and achievement (Davis et al., 2017; Fisher & Cox, 2008). Moreover, men exhibit more frequent aggressive behavior which centers on the acquisition or maintenance of mates (Daly & Wilson, 1989; Kruger & Nesse, 2006). Women's reproductive variance is lower than men's, and because prolonged dependence of offspring on their mothers makes it more important for women to stay alive to successfully reproduce (e.g., Sear et al., 2002), there is stronger selection pressure on women to avoid the risks associated with physically aggressive competition (Campbell, 1995).

Interest in the diverse ways that intrasexual competition manifests itself among humans has led to the development of a scale to measure attitudes toward same-sex competitors—the Intrasexual Competition Scale (ICS) Buunk & Fisher, 2009). The ICS seeks to measure the extent to which individuals view interactions with members of the same sex, especially when in the presence of members of the opposite sex, in competitive terms. The ICS was designed to focus on the variation in individuals' attitude toward same-sex competitors with the intent of designing a scale that was not biased by sex and thus allowed for cross-sex comparison.

The manuscript detailing the development of the ICS has been cited over 200 times (as of August 2021) and has been administered to adolescent and adult samples from a variety of cultural backgrounds (e.g., Buunk & Fisher, 2009; Klavina & Buunk, 2013). The scale score has been used in studies as the primary dependent variable (e.g., Buunk et al. 2014) and the independent and/or mediator variable in several investigations analyzing the effects of intrasexually competitive attitude on tendency to engage in aggressive or mating-relevant behaviors (e.g., Arnocky et al., 2018; Davis et al., 2017; van Brummen–Girigori & Buunk, 2016).

Past research (e.g., Arnocky et al., 2014a, 2014b, 2018; Davis et al., 2017; van Brummen–Girigori & Buunk, 2016) used a single score to summarize responses to ICS items because Buunk and Fisher (2009) recommended using a single score. However, within the original report describing the ICS' factor structure, Buunk and Fisher (2009) indicated that there were three minor factors with eigenvalues greater than one, raising the possibility that the ICS is not unidimensional. Instead, multiple factors may capture more of the construct space and provide researchers with a more complete understanding of variation in ICA. More studies are necessary to corroborate the results of this initial exploratory study. Studies employing confirmatory factor analysis (CFA), which is hypothesis driven and used to verify the number of factors and patterns of factor-item relationships (Brown, 2014), can provide stronger evidence for or against the adoption of a unidimensional measurement model.

In addition to confirming dimensionality, studies using CFA can also evaluate whether the scale measures the same construct(s) across the sexes. Because the ICS was designed to be sex neutral (Buunk & Fisher, 2009), affirming the equivalence of the model between the sexes is critical. Measurement invariance is a statistical property of an instrument indicating that it measures the same construct(s) in the same way across subgroups of respondents (Meredith, 1993; Millsap, 2012; Wang et al., 2018). Since the inception of the ICS, no study has tested it for measurement invariance between the sexes. Because one of the key areas of study in evolutionary and personality psychology is sex differences, tests of measurement invariance are especially important in these fields. Critically, if scales used by researchers to measure sex differences are not invariant, then conclusions made by comparing the average scale scores of men and women are inappropriate because these differences may be confounded by measurement bias (Wang et al., 2018).

Current Project

To address the psychometric gaps highlighted above, we carried out two studies to evaluate the validity of the ICS and determine how it should be scored. Study 1 explored the factor structure of the ICS in a diverse sample of men and women. In Study 2, we sought to confirm the factor structure found in Study 1 with an independent sample and then evaluate if the ICS measured the same underlying constructs between the sexes (i.e., by testing for measurement invariance and population heterogeneity). We also assessed the reliability of its factors for both sexes. We examined its concurrent validity via associations with sociosexuality, mating effort, and proxies of reproductive success.

Sample Size Estimation

We used the *pwrSEM* package recently developed by Wang and Rhemtulla (2021) to estimate power for detecting a between construct structural effect given an alpha of 0.05, a sample size of 263 (our smallest across the studies), an average factor loading of 0.40 for the 12 ICS items (i.e., reliability of 0.70), and a single-item outcome uncorrected for measurement error (similar to our external criterion of number of sexual partners). We found power equal to 0.80 to detect a structural effect as small as 0.21, suggesting our studies were adequately powered to detect small effects on external criteria.

Study 1: Exploring the Structure of the Intrasexual Competition Scale

Participants

Participants were recruited via Amazon's Mechanical Turk (MTurk) online sampling technologies. The questionnaire was programmed in Qualtrics and administered via MTurk. To reduce the number of respondents who engaged in insufficient responding effort, all respondents were required to have a HIT approval rating of 95%. Previous investigations have shown that MTurk participants are significantly more diverse than convenience samples of university undergraduates (frequently used in traditional lab studies; Buhrmester et al. 2011; Casler et al., 2013), and provide data of equivalent quality to that provided by in-lab participants (Buhrmester et al., 2016; Casler et al., 2013; Hauser & Schwarz, 2016). Therefore, our results should generalize more broadly than traditional laboratory samples of university undergraduates. As part of a larger study on mating behavior, participants completed a demographics and lifestyle questionnaire, and the ICS. Participants were remunerated with 2.00 USD for completing the survey package. The study and all materials were approved by the Boston University Institutional Review Board.

The sample was the same as the one described in Albert et al. (2021), which sought to validate a new measure of human mating effort.[1] All respondents had to be 18 years of age and over, and native English speakers. In total, 341 individuals completed the questionnaire. All repeated IP addresses were excluded from analysis, resulting in the removal of 20 cases. To determine sexual orientation, participants indicated whether they were primarily attracted to men, women or both sexes by selecting from one of four response options (1 = men, 2 = women, 3 = both, 4 = prefer not to answer). We restricted the sample to those identifying as heterosexual, resulting in the exclusion of 50 respondents (females = 35 and males = 15) because we were unsure if individuals with a non-heterosexual orientation would respond to the items of the ICS in the same way as heterosexual men and women, and there were too few cases to test this possibility. After these procedures, data from 271 individuals (134 males and 137 females) were used in the analysis. Women were aged 19 to 72 (M_{age} = 36.96, SD = 11.09), while men were aged 19 to 73 (M_{age} = 35.29, SD = 10.61). The respondents were recruited primarily from the USA (76.1%) and India (15.4%), with nineteen countries making up the rest of the respondents (8.5%), contributing less than 1% of the cases.

Measures

Demographic and Lifestyle Questionnaire

We administered a survey to ascertain sex, age, ethnicity, sexual orientation, and relationship status.

Intrasexual Competition

Respondents completed the ICS (Buunk & Fisher, 2009). The measure consists of 12 items (see the Appendix for the items). Respondents used a 7-point Likert-type scale anchored at 1 = "*not at all applicable*" to 7 = "*completely applicable*," to indicate the degree to which each statement was true of them.

[1] The questionnaires administered to both samples were: the ICS, the Mating Effort Questionnaire, the Sociosexual Orientation Inventory Revised (SOI-R), Mating Retention Inventory Short-Form and the Mini-K (not used in the current study). These measures were selected to measure mating effort and facets related to the construct, such as openness to engaging in casual sex (SOI-R), attitudes toward competing with same-sex others when in the presence of members of the opposite sex (ICS) and individual differences in life history strategy. These measures each provide unique information on individuals' mating behavior.

Analysis

Data Screening

All cases and study variables were examined for missing values and violations of the assumptions of multivariate analysis (i.e., additivity, normality, linearity, and homogeneity of variance). Skewness values for the 12 items ranged from 1.17 (Item 8) to − 0.23 (Item 4) indicating that the item distributions were relatively normal. There were no missing data. Eight multivariate outliers were detected using Mahalanobis distance statistic ($\chi^2[14] = 36.12$, $p < .001$) and deleted, leaving 263 cases for analysis. Identifying multivariate outliers using Mahalanobis distance statistic and removing them is common practice in psychological research (Tabachnick & Fidell, 2013).

Exploratory Factor Analysis (EFA)

We conducted EFAs to analyze the underlying factor structure of the ICS using the *psych* package in R (Revelle, 2017). EFAs were conducted using the guidelines outlined by Preacher and MacCallum (2003). To achieve simple structure, all items with cross-loadings outside of ± 0.30 were eliminated. Maximum likelihood estimation was used with direct Oblimin rotation because of expected factor correlations. Bartlett's test indicated correlation adequacy ($\chi^2[66] = 2385.41$, $p < .001$) and the KMO test indicated sampling adequacy (MSA = 0.92).

Model Fit

For all EFA and CFA analyses, we evaluated the goodness of fit using the global χ^2 test of fit, the standardized root mean square (SRMR), the Root Mean Square Error of Approximation (RMSEA; Steiger, 1990) and its 90% confidence interval (cf. MacCallum et al., 1996), the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), and the Comparative Fit Index (CFI; Bentler, 1990). Acceptable model fit was defined as follows: a non-significant χ^2 test, SRMR < 0.08, RMSEA < 0.06 (90% CI 0.05–0.08), CFI > 0.95, and TLI > 0.95.

Results

Exploratory Factor Analysis

All 12 items were submitted to the EFA. A parallel analysis recommended two factors, whereas the scree plot and Kaiser's old criterion recommended one factor. We elected to conduct both a one-factor and two-factor EFAs and compare the model fit of the EFAs. Regarding the one-factor solution, one EFA was conducted, and no items were dropped. The one-factor solution did not fit the data well. For goodness-of-fit statistics and factor loadings, see Table S1 in Supplement 1. The one-factor solution explained 55% of the variance and appeared to measure respondents' intrasexually competitive attitude.

Although the CFI, TLI, and RMSEA were still outside of their specified cutoff values, the two-factor model improved the fit of the data (Table S3) and explained 65% of the variance. Factor 1 accounted for 47% of the variance, contained eight items, and appeared to measure respondents' negative emotions and attitudes toward intrasexual competitors (hereafter Inferiority Frustration). Factor 2 accounted for 18% of the variance, contained four items, and appeared to measure respondents' enjoyment of being better than intrasexual competitors (hereafter Superiority Enjoyment). The correlation between the factors was 0.60. Please see Table 1 for factor loadings of the two-factor model. Importantly, the two-factor solution could stem from a difference in item wording from items making up the Superiority Enjoyment factor (Items 4, 9, 10, and 11; cf. Brown, 2003). In Study 2, we test for this by specifying all ICS items as loading on a single factor, while freely estimating error covariances among the items that reflect the Superiority Enjoyment factor (cf. Brown, 2003). We compare the fit of this model to the two-factor model to determine if the scale is best conceptualized as a one-factor or two-factor solution. We also examine the nomological nets of the two factors (i.e., their patterns of covariance with other constructs) to evaluate their concurrent validity. Importantly, if the nomological nets of the two factors differ in theoretically plausible ways, this suggests the two-factor solution is not simply an artifact of the two evaluative valences in the item contents. For items and scoring instructions, please see the Appendix.

Study 2A: Confirming the Structure of the Intrasexual Competition Scale

The primary purposes of Study 2 were to: (1) confirm the structure of the ICS found in Study 1, (2) compare the fit of this factor structure to a one-factor solution with correlated item residuals, (3) evaluate if the scale measures the same underlying constructs between men and women by conducting tests for measurement invariance and population heterogeneity using multiple-groups CFAs (MGCFAs), (4) to evaluate scale reliability, and (5) assess concurrent validity via associations of the ICS factors with distinct, but related constructs.

Participants

The sample was the same as the one described in Albert et al. (2021, Study 2). Participants were recruited in the same

Table 1 List of items of the Intrasexual Competition Scale, goodness-of-fit statistics, and factor loadings

Item	Inferiority frustration	Superiority enjoyment
3	**0.86**	0.05
7	**0.86**	0.04
5	**0.83**	− 0.07
1	**0.81**	0.00
2	**0.79**	0.09
8	**0.79**	− 0.09
6	**0.78**	− 0.09
12	**0.73**	0.13
10	− 0.06	**0.96**
9	0.05	**0.69**
11	0.28	**0.58**
4	0.29	**0.45**

	χ^2	*df*	SRMR	RMSEA	90% CI	CFI	TLI
2-factor model	209.81	43	0.04	0.12	0.11–0.14	0.928	0.889

manner as in Study 1 and were remunerated with 1.50 USD for completing the questionnaire. The study and all materials were approved by the Boston University Institutional Review Board. All repeated IP addresses were excluded from analysis, resulting in the exclusion of 17 cases. In total, 428 individuals completed the questionnaire. We excluded individuals who did not report a heterosexual orientation ($n = 44$, females = 30, males = 14) for the same reasons as in Study 1. In addition, these individuals were excluded because of our interest in using the Sociosexual Orientation Inventory Revised to assess the ICS' concurrent validity. The items of the Revised Sociosexual Orientation Inventory focus on respondents' frequency and desire for uncommitted heterosexual intercourse as well as their attitude toward this behavior (cf. Penke and Asendorf 2008).

Data from 367 participants (186 males and 181 females) were analyzed. Age range for female participants was 19 to 70 ($M_{age} = 39.13$, SD = 11.38) and the age range for male participants was 21 to 76 ($M_{age} = 36.25$, SD = 11.57). The respondents were recruited primarily from the USA (64.6%), India (28.4%), and a group of eighteen countries (7%), each of which contributed to less than 1% of the cases.

Measures

The Study 1 demographics and lifestyle questionnaire, the ICS, the Revised Sociosexual Orientation Inventory (Penke & Asendorf, 2008), the Mating Effort Questionnaire (Albert et al., 2021), and the Mate Retention Inventory Short Form (Buss et al., 2008) were administered in Study 2. These measures will be described in greater detail in Study 2B. Below we describe the CFAs, MGCFAs, and reliability analysis conducted on the ICS.

Analysis

Data Screening

The variables were examined for the 365 remaining cases in the study. Skewness values for the 12 items ranged from 0.93 (item 8) to − 0.16 (item 10) and kurtosis values ranged from 0.38 (item 7) to − 1.15 (item 10) indicating that item distributions were relatively normal. All 365 cases were analyzed for the presence of missing data. Five cases were eliminated for having greater than 5% missing data. After eliminating these cases, we inspected the items for missing data and found that none of the 12 items for the remaining 363 cases had missing data. Fourteen multivariate outliers were detected using the Mahalanobis distance statistic of ($\chi^2[15] = 7.70$, $p < .001$) (Tabachnick & Fidell, 2013). These outliers were deleted, leaving 351 cases for analysis. The assumptions of multivariate analysis were met.

Results

Confirmatory Factor Analysis

We conducted four CFAs using the *lavaan* package in R (Rosseel, 2012). We first conducted a CFA to compare the two-factor model found in Study 1 against a one-factor model, and to a one-factor model with correlated error variances.

The one-factor model (Model 1) did not fit the data well (Table S4). Next, we tested a one-factor solution with correlated errors, to assess whether the second factor found in Study 1 reflected a method effect stemming from similarity in item wording (cf. Brown, 2003). To do this, we specified error covariances between Items 4, 9, 10, and 11 and tested

Table 2 Goodness-of-fit indices, unstandardized and standardized factor loadings, standard errors, significance values, and R^2 values for Model 4

Factor	Item	b	SE	p	β	R^2
Inferiority frustration	1	1.00			0.87	0.75
Inferiority frustration	2	0.96	0.05	< .001	0.81	0.65
Inferiority frustration	3	0.96	0.05	< .001	0.83	0.68
Inferiority frustration	5	0.97	0.05	< .001	0.84	0.70
Inferiority frustration	6	0.95	0.05	< .001	0.83	0.69
Inferiority frustration	7	1.05	0.05	< .001	0.87	0.75
Inferiority frustration	8	0.90	0.05	< .001	0.81	0.66
Inferiority frustration	12	0.95	0.05	< .001	0.81	0.65
Inferiority frustration	11	0.46	0.06	< .001	0.37	0.60
Superiority enjoyment	10	1.00			0.91	0.83
Superiority enjoyment	4	0.73	0.05	< .001	0.68	0.46
Superiority enjoyment	9	0.83	0.05	< .001	0.77	0.59
Superiority enjoyment	11	0.53	0.06	< .001	0.48	0.60

	χ^2	df	SRMR	RMSEA	90% CI	CFI	TLI	AIC	BIC
Model 4	161.99	52	0.03	0.08	0.06–0.09	0.966	0.957	13,796.76	13,897.14

Inferiority Frustration is a short for the Inferiority Frustration factor and Superiority Enjoyment factor

the fit of this re-specified one-factor model. The significant χ^2 test indicated that the one-factor model with correlated error terms did not fit the data exactly (Model 2); however, the remaining goodness–of-fit indices met their specified cutoffs (Table S4). Model 2 produced a significantly better fit to the data than Model 1 ($\Delta\chi^2[6] = 316.64$, $p < .001$).

Next, we tested the two-factor solution found in Study 1, in which Items 4, 9, 10, and 11 loaded onto their own factor (Model 3). Model 3 fit the data well (see Table S5), although the χ^2 test was significant and the TLI and RMSEA did not meet their specified cutoffs. The factor correlation was large (cov = 1.73, $r = 0.69$, $z = 9.34$, SE = 0.19, $p < .001$). A χ^2 difference test comparing the fit of Model 3 to Model 2 revealed that Model 2 fit significantly better ($\Delta\chi^2[5] = 51.58$, $p < .001$).

We examined modification indices (MIs) to identify any sources of strain in Model 3. We found relatively large MIs (> 20) suggesting that allowing item 11 to cross-load on the Inferiority Frustration factor (MI = 50.35) would result in significant improvement in fit. This re-specified model (Model 4) fit the data well (Table 2). We conducted a χ^2 difference test to determine if Model 4 fit significantly better than Model 3 and found evidence that it did ($\Delta\chi^2[1] = 48.12$, $p < .001$). The factor covariance was significant and in the predicted direction (cov = 1.63, $r = 0.63$, $z = 8.88$, SE = 0.18, $p < .001$).

We tested the fit of Model 4 against the fit of Model 2. The fit of the models did not significantly differ ($\Delta\chi^2[4] = 3.46$, $p = .48$). To further compare the two models, we inspected the AIC and BIC. Both the AIC and BIC were smaller for Model 4 (AIC = 13,796.76, BIC = 13,897.14) versus Model 2 (AIC = 13,801.30, BIC = 13,917.12). Because the BIC was 10 points smaller for Model 4 than for Model 2, we elected to proceed with Model 4 as it more closely reflected the "true" model (Burnham & Anderson, 2002). Additionally, a two-factor model was more parsimonious, such that it only had a single-item cross-loading. Please see Figure S4.

We proceeded to inspect the factor loadings of Items 4, 9, 10, and 11 on the Superiority Enjoyment factor, in Model 4, and compared the strength of these loadings to the strength of the loadings in Model 2. Items 4, 9, and 10 all had stronger factor loadings when they loaded onto their own factor (Please compare Table 2 with Table S4), allowing us to capture more information with two factor scores than with one. For these reasons, we proceeded to test Model 4 for measurement invariance.

To further evaluate that the ICS reflected a single general construct of intrasexually competitive attitude, or if it was best reflected by two factors, we also tested a bi-factor model with a general intrasexual competition factor and two orthogonal group-specific factors which functioned to capture variance due to positive and negative item wording. Ultimately, a bi-factor model with a general intrasexual competition factor and one group-specific factor, representing respondent's Superiority Enjoyment yielded a good fit. We repeated our analysis for Study 2B with this bi-factor model. We encourage the interested reader to review Supplement 2 where we discuss the results of our analysis and possibilities for scoring the ICS (Fig. 1).

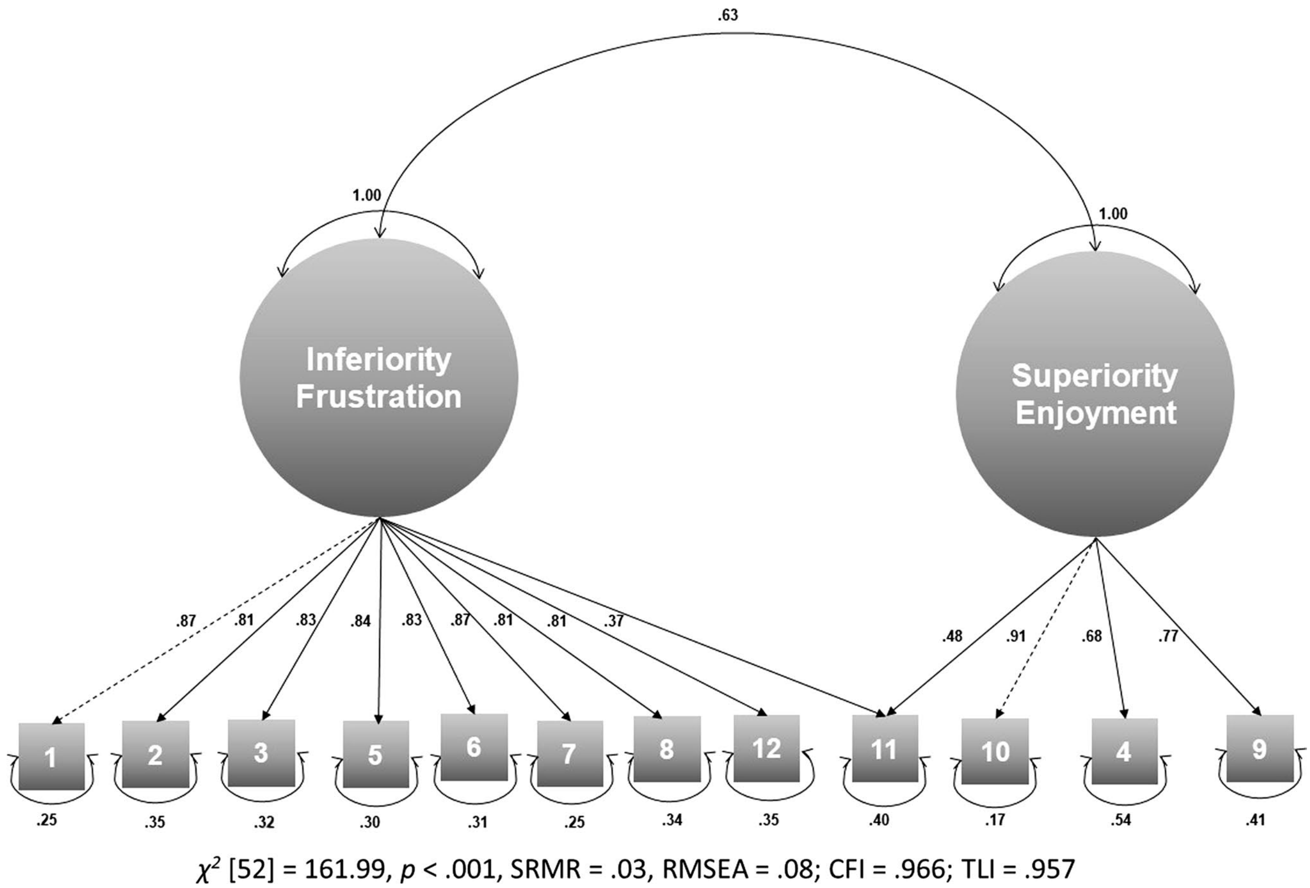

Fig. 1 Path diagram depicting the two-factor solution of the ICS, Model 4 with an item cross-loading. Note that the item loadings and residuals are standardized

Test of Scale Equivalence Between the Sexes

To further evaluate the stability and generalizability of Model 4, we used MGCFAs to test it for measurement invariance (e.g., equal-factor loadings and intercepts) and population heterogeneity (e.g., equal-factor variances and means) between the sexes. We conducted χ^2 difference tests to assess degradation in model fit. When the χ^2 test revealed significant degradation, we relaxed equality constraints one by one to identify non-invariant parameters.

Measurement Invariance

We tested and found equal form between the sexes, indicating that the model fit the data from both groups well (Table 3), demonstrating configural invariance. Given the evidence of equal form, we conducted a series of two-group CFAs in which we increased the number of equality constraints. Equality constraints on the factor loadings did not significantly degrade the fit of the model ($\Delta\chi^2[11] = 18.27$, $p = .76$), providing evidence of metric invariance. We tested for scalar invariance, by constraining the item intercepts to equality, which resulted in significant model-fit degradation ($\Delta\chi^2[10] = 39.11$, $p < .001$). We proceeded to analyze the parameter constraints to identify non-invariant item intercepts.

To achieve partial scalar invariance, we released item intercepts one at a time and tested if freeing the item intercept reduced the χ^2 difference test so that it was no longer significantly different from the previous equal-item loadings model. In total, we freed the intercepts of four items: Item 6 (EPC = 0.12), Item 11 (EPC = − 0.23), Item 8 (EPC =− 0.11), and Item 7 (EPC =− 0.11). Releasing the intercepts of these four items produced a partial scalar invariance model that fit the data well, and no longer resulted in significant degradation in model fit from the equal-item loadings model ($\Delta\chi^2[6] = 9.83$, $p = .13$).

Next, we tested for strict invariance by constraining the item residual variances to equality. However, constraining the item residuals to equality did result in significant model-fit degradation ($\Delta\chi^2[12] = 38.82$, $p < .001$). We analyzed the parameter constraints to identify non-invariant item residuals. In total, we freed the item residuals of three items: Item 6 (EPC =− 0.26), Item 4 (EPC =− 0.46), and

Table 3 Goodness-of-fit indices for the multiple-group confirmatory factor analysis testing Model 4 to ensure that the scale items loading on the same factors between the sexes (configural invariance) and that the factor loading are the equivalent between the sexes (metric invariance)

	χ^2	*df*	χ^2diff	Δ *df*	CFI	RMSEA	Δ CFI	ΔRMSEA
Equal form	234.71	104			0.960	0.09		
Equal-item loadings	252.98	115	18.26	11	0.958	0.08	0.002	0.002
Equal-item intercepts	292.09	125	39.11**	10	0.949	0.09	0.009	0.004
Partial equal-item intercepts	262.81	121	9.83	6	0.957	0.08	0.008	0.005
Partial equal-item residuals	301.63	133	38.82**	12	0.949	0.09	0.006	0.003
Revised partial equal-item residuals	272.74	130	9.93	9	0.957	0.08	0.006	0.006
Partial equal latent variances	273.22	132	0.48	2	0.957	0.08	0.00	0.001
Partial equal latent covariances	281.11	133	7.89**	1	0.955	0.08	0.002	0.002
Partial equal latent means	285.05	134	3.94**	1	0.954	0.08	0.001	0.00

For the partial equal-item intercepts model, we freed the intercepts of Items 6, 11, 8, and 7. For the participant equal-item residuals, we freed the residuals of Items 6, 4, and 11. For the partial equal latent covariance model, we had to free the covariance between the Inferiority Frustration factor and Superiority Enjoyment factor

** indicates a significant χ^2 difference test of $p < .05$ or lower

Item 11 (EPC =− 0.30). Releasing the residual variances of these three items produced a partial equal-item residuals model that fit the data well, and no longer produced significant degradation in model fit from the equal-item loadings model ($\Delta\chi^2[9] = 9.93$, $p = .36$).

Population Heterogeneity Imposing equality on the factor variances did not result in significant model-fit degradation ($\Delta\chi^2[2] = 0.48$, $p = .79$). However, constraining the factor covariances resulted in significant model-fit degradation from the previous model ($\Delta\chi^2[1] = 7.89$, $p = .004$), indicating that the relationship between the Inferiority Frustration factor and the Superiority Enjoyment factor was not equivalent between the sexes. Inspecting the covariance values in the previous equal-factor variance model revealed that the magnitude of the relationship of the factor covariance was greater in women (cov = 1.84, $r = 0.72$, $z = 9.33$, SE = 0.20, $p < .001$) than in men (cov = 1.34, $r = 0.52$, $z = 6.58$, SE = 0.20, $p < .001$). Next, we constrained the factor means and tested whether this resulted in significant model-fit degradation from the partial equal-factor variances model. A χ^2 difference test revealed that this model resulted in significant model-fit degradation from the previous model ($\Delta\chi^2[1] = 3.94$, $p = .047$), indicating that the factor means of the ICS significantly differed between the sexes. Inspecting the factor means of the previous model revealed that women scored significantly lower on the Superiority Enjoyment factor ($b = -0.62$, $\beta = -0.37$, $z = -3.21$, SE = 0.19 $p = .001$). The sexes did not differ on their latent mean for the Inferiority Frustration factor ($b = -0.12$, $\beta = -0.08$, $z = -0.70$, SE = 0.17 $p = .49$). Please see Table 3 for the goodness-of-fit indices for the MGCFAs.

The finding that men scored higher on Superiority Enjoyment is in line with two evolutionary theories: Parental investment (Trivers, 1972), and sexual selection theory (Buss, 1988). Women have higher obligate parental investment than men and tend to be choosier when selecting a mate (Buss, 1988) and compete among themselves for access to the highest quality men (Buss, 1988). Men can increase their reproductive output by allocating more effort to intrasexual competition (Buss & Schmitt, 1993). Men's reproductive variance is greater than that of women, and they can increase their reproductive success by mating with multiple women. Therefore, men might derive greater enjoyment from being better than their intrasexual competitors, because being better has greater consequences for their reproductive success. The fact that the sexes meaningfully differ in their level of Superiority Enjoyment in a way that would be predicted from Parental Investment (Trivers, 1972), and Sexual Selection Theory (Buss, 1988) provides additional evidence that the ICS is a two-factor scale.

Additionally, we tested whether the item means varied significantly by age, relationship status, and whether patterns of item responding were similar between individuals of the two most reported ethnicities, White and South Asian. In brief, patterns of item responding remained constant regardless of respondent age, relationship status, and self-reported ethnicity (see Supplement 1).

Scale Reliability

We computed the composite reliability for the two factors using the method developed by Fornell and Larcker (1981). We use this method in addition to computing Cronbach's α, because Cronbach's α misestimates scale reliability except in the instances where elements of a multi-item measure are tau-equivalent and free from non-random measurement error (Stijsma, 2009). However, because Cronbach's α is so ubiquitous in psychological measurement, we report it as well. All reliability coefficients were greater than 0.70, indicating acceptable reliability (Cronbach, 1951). Please see Table 4 for the reliability coefficients of the two factors for the entire sample, and the sample divided by sex.

Table 4 Reliability coefficients ρ and α for the two factors for the entire sample as well as broken down by sex

	Inferiority frustration			Superiority enjoyment		
	All	Male	Female	All	Male	Female
ρ	0.91	0.94	0.95	0.84	0.81	0.87
α	0.95	0.94	0.95	0.85	0.81	0.88

Study 2B: Nomological Net of the Intrasexual Competition Scale

The goal of study 2B was to evaluate the concurrent validity of the ICS. In addition to responses to the ICS, we also analyzed participants' responses to the Revised Sociosexual Orientation Inventory, the Mating Effort Questionnaire, the Mate Retention Inventory Short Form, and questions on respondents' sexual behavior. We conducted two structural equation models. In the first model, we tested whether respondents' sociosexual attitude and desire predicted their scores on the ICS factors, and whether the two ICS factors predicted different aspects of respondents' mating effort. In the second model, we were interested in the extent to which ICS factors predicted mating outcomes including respondents' relationship status, total number of romantic partners, number of sex partners, number of past-year sex partners, and frequency of intercourse in the past month.

Study Purposes and Hypotheses

In the first model, we were interested in determining if respondents' positions on the two factors of the ICS were predicted by their sociosexual attitude and desire, and if together with the factors of the Revised Sociosexual Orientation Inventory, the factors of the ICS predicted components of mating effort. We expected that respondents' level of sociosexual attitude and desire would significantly predict both ICS factors. Previous research has demonstrated that those individuals who have an unrestricted sociosexual orientation are more likely to derogate competitors when trying to secure a short-term mate (Bleske-Rechek & Buss, 2006), and are more likely to use more overt non-verbal seduction strategies when trying to attract mates (van Brummen–Girigori & Buunk, 2016). We expected that those who reported higher levels of intrasexually competitive attitude would also score higher on measures of mating effort, even after their levels of sociosexual attitude and desire were controlled. We expected that those who reported higher Inferiority Frustration would report engaging in higher rates of cost-inflicting mate retention (cf. Buss et al., 2008), and higher levels of partner-upgrading and mate-seeking behaviors (Albert et al., 2021). Furthermore, we expected that respondents who reported higher Superiority Enjoyment would report engaging in more benefit-provisioning mate retention behaviors (Buss et al., 2008) and report higher levels of partner-upgrading and mate-seeking behaviors (Albert et al., 2021). Previous research has demonstrated that high mate value individuals who are satisfied in their relationship are more likely to use benefit-provisioning mate retention strategies (Conroy-Beam et al., 2016). Importantly, evidence consistent with these divergent predictions about the nomological nets of the two ICS factors would help us rule out the possibility that the two-factor structure is an artifact of positive and negative item wording.

For the second model, we tested the extent that intrasexually competitive attitude predicted proxies of respondents' mating success, that is the number of sex partners and the frequency of intercourse individuals report. These measures of sexual behavior provide a good proxy for respondents mating success and help us understand respondents mate value (Fisher et al., 2008). We refer to this as mating success, and not reproductive success, because our sample comes from industrialized societies with access to modern contraception. Frequency of sexual intercourse can index female's mate value. For example, females who are low in mate value may have difficulty obtaining copulatory opportunities, in part because intercourse in humans has the potential to lead to longer-term relationships and male investment. Conversely, females who are higher in mate value may experience more male coercion, courtship, and repeated copulation attempts. Relative to lower mate value females, they may have more opportunities for intercourse, which for high mate value females with less restricted sociosexual orientations may result in more sex partners and higher intercourse frequency. We expected that those who scored higher on the ICS factors would also report greater mating success in terms of their number of total past-year romantic and sex partners, because they would be more willing to compete with conspecifics for mates. We expected those who reported greater Inferiority Frustration and Superiority Enjoyment to be more likely to be in a relationship, to have had more lifetime romantic and sex partners (after controlling for age), to report a younger age at first sexual intercourse (controlling for sex), and to report more past-year sex partners and a higher frequency of intercourse in the past month (controlling for relationship status). We expected high levels of intrasexually competitive attitude to lead to higher mating success, as individuals would demonstrate a greater willingness to obtain mating opportunities despite competitors.

In support of our hypothesis, aggressive individuals of both sexes have greater reproductive success (Volk et al., 2012; White et al., 2010). Adolescent girls who engaged in higher levels of indirect aggression toward their peers reported a younger age at first sexual intercourse (White et al., 2010). Correspondingly, adolescent girls who reported engaging in more indirect aggression were also more likely to have a dating partner one year later, whereas those who were the victim of higher rates of indirect aggression were significantly less likely (Arnocky & Vaillancourt, 2012). Therefore, individuals who are more intrasexually competitive should experience greater mating success, than less intrasexually competitive individuals. To correct for an inflated Type 1 error, due to multiple hypothesis testing, we employed a conservative α value of 0.005 (Benjamin et al., 2018).

By conducting these analyses, we were seeking to evaluate the concurrent validity of the two-factor structure of the ICS. Evidence that the two intrasexual competition factors predicted unique aspects of respondents' reproductive strategies, or that they were related to the same outcome but in an opposite manner would provide evidence that there are two theoretically coherent ICS dimensions that provide unique information about individual differences in intrasexual competition.

Instruments

Sociosexual Orientation

Sociosexual orientation refers to an individual's willingness to engage in uncommitted sexual relationships (Gangestad & Simpson, 1990; Penke & Asendorpf, 2008). To measure sociosexual orientation, we used the Revised Sociosexual Orientation Inventory (Penke & Asendorf, 2008). High scores on this measure indicate individuals are comfortable engaging in uncommitted sexual relationships whereas low scores indicate that the individual needs to form an intimate relationship before having intercourse (Penke & Asendorpf, 2008). The measure includes nine items that measure past sexual behavior, attitude toward non-committal sex, and sociosexual desire. The three-factor model fit the data well (see Supplement 1 for more detail). The reliabilities of the factors were good: Behavior: $\rho = 0.88$, Attitudes: $\rho = 0.78$, and Desire: $\rho = 0.91$.

Mating Effort

Mating effort refers to the allocation of energy toward current mates, or toward seeking new mating opportunities. Importantly, the extent to which individuals allocate energy to mating should be positively related to their trait levels of intrasexual competition, because those who perceive they are competing more vigorously for mates should also report allocating more energy to mating. To measure mating effort, we used the Mating Effort Questionnaire, and Mate Retention Inventory Short Form (Buss et al., 2008).

Mating Effort Questionnaire The Mating Effort Questionnaire measures the energy that respondents allocate toward seeking, attracting, and retaining romantic partners (Albert et al., 2021). The scale measures the energy respondents allocate to seeking out new mating opportunities (i.e., mate seeking), toward attracting higher mate value partners when already mated (i.e., partner upgrading), and toward investing in current romantic partners (i.e., partner investment). A previous investigation by Albert et al., (2021) demonstrated that a three-factor model fit the data well and corresponded to the above factors and that all three factors had good reliability ($\rho = 0.80$ to $\rho = 0.81$). This measure serves as a good complement to the Mate Retention Inventory Short Form which focuses on energy allocated to retaining current romantic partners (Buss et al., 2008).

Mate Retention Inventory Short Form The Mate Retention Inventory Short Form contains 38 items along which respondents indicate how often they have performed the target behavior in the past year, using a Likert-type scale ranging from 0 = "*Never*" to 3 = "*Often*." Based on the results of a confirmatory factor analysis, the Mate Retention Inventory Short Form appears to be made up of five lower-order factors. Briefly, the five factors of the Mate Retention Inventory Short Form appeared to measure respondents' cost-inflicting mate retention behaviors, benefit-provisioning mate retention behaviors, commitment manipulation, infidelity threat, and their signals of possession (cf. Buss et al., 2008). This model fit the data well (see Supplement 1 for more detail). The reliability of the factors ranged from adequate (Benefit provisioning: $\rho = 0.62$) to good (Cost Inflicting: $\rho = 0.82$).

Analysis

We conducted two structural equation models (SEMs) using the *lavaan* package in R (Rosseel, 2012).

Data Screening

The descriptive statistics for the three scales showed that the items were relatively normally distributed. However, the self-reported measures of reproductive success were not. Skewness values ranged from 7.88 (respondents self-reported number of past-year sex partners) to 0.94 (item 6 of the Mate Retention Inventory Short Form). The following variables were log10 transformed because of significant positive skew: respondents' total number of romantic partners, total lifetime sex partners, number of past-year sex partners, and frequency of intercourse in the past month. The log10 transform was effective at reducing skewness for these variables. Four cases were missing more than 5% of the data, and were excluded from analysis, leaving 364 cases. After excluding these cases, less than 5% of the data was missing in all instances and we imputed these missing values using the R package, *mice* (van Buuren & Groothuis-Oudshoorn, 2011). Fourteen multivariate outliers were detected using Mahalanobis distance statistic ($\chi^2[82] = 127.32$, $p < .001$). These outliers were deleted, leaving 349 cases for analysis (Tabachnick & Fidell, 2013). The assumptions of multivariate analysis were met.

Results

Mating Effort and Sociosexuality

To test the concurrent validity of the ICS, we conducted a SEM in which we specified that sociosexual attitude and desire (Revised Sociosexual Orientation Inventory) should predict the ICS factors. We specified that respondents' Inferiority Frustration should predict respondent's frequency of reporting cost-inflicting mate retention behavior (Mate Retention Inventory Short Form) and respondents' Superiority Enjoyment should predict respondents' frequency of reporting benefit-provisioning mate retention behavior (Mate Retention Inventory Short Form). We specified that both ICS factors should predict respondents' levels of partner-upgrading and mate-seeking behaviors (Mating Effort Questionnaire,). This model (Model 5) had a combination of good and poor fit statistics, as the CFI and TLI were below their specified cutoffs (see Table 5).

Revised Sociosexual Orientation Inventory Regarding the sociosexual desire factor of the Revised Sociosexual Orientation Inventory, respondents who reported high levels of sexual desire also reported higher Superiority Enjoyment and Inferiority Frustration. Interestingly, individuals who scored lower on the sociosexual attitudes factor (i.e., those who indicated being less willing to engage in uncommitted sexual relationships) reported greater *Inferiority Frustration*.

Mate Retention Inventory Short Form We found that respondents' who reported higher Inferiority Frustration reported a greater frequency of engaging in cost-inflicting mate retention behaviors. Although Inferiority Frustration significantly predicts Cost-Inflicting mate retention and Superiority Enjoyment significantly predicts Benefit-Provisioning mate retention the relationships between these constructs are not so strong to suggest that Inferiority Frustration and Cost-Inflicting mate retention, or Superiority Enjoyment and Benefit Provisioning, are the same constructs.

Mating Effort Questionnaire Those respondents who reported greater Inferiority Frustration reported greater willingness to pursue higher mate value partners when they were already mated. This suggests that more intrasexually competitive individuals have a higher drive to obtain their ideal partner. Moreover, respondents who reported higher levels of Superiority Enjoyment scored higher on the mate-seeking factor, suggesting that those who derive more pleasure from being better than same-sex competitors also reported greater willingness to enter environments in which there were members of the opposite sex. Please see Fig. 2.

Proxies of Reproductive Success

In Model 6, we tested the extent to which the two factors of the ICS predicted respondents' age at first sexual intercourse, controlling for respondent sex. Furthermore, we tested the extent to which the two factors of the ICS predicted respondents' log number of lifetime romantic partners and sex partners, controlling for their age. Additionally, we tested the extent to which the factors of the ICS predicted respondents' log number of past-year sex partners, and log frequency of past-month intercourse, controlling for their relationship status. This model (Model 6; Fig. 3) had a combination of good and poor fit statistics (Table 5).

Respondents who reported higher levels of Inferiority Frustration also reported a significantly later age at first sexual intercourse controlling for sex. Respondents' who reported higher levels of Inferiority Frustration reported significantly fewer total lifetime romantic partners and fewer total lifetime sex partners controlling for age. Similarly, respondents who reported higher levels of Inferiority Frustration reported having sexual intercourse less frequently in the past month, even after their relationship status was controlled. These respondents were also less likely to indicate that they were in a romantic relationship; however, this relationship was no longer significant after we corrected for multiple comparisons (Benjamin et al., 2018).

Those respondents who reported greater Superiority Enjoyment reported significantly more total lifetime romantic partners and total lifetime sex partners controlling for respondents' age. Please see Table 5 for all standardized and unstandardized regression coefficients for Model 5 and 6 (Table 6).

General Discussion

The ICS is widely used by researchers studying human mating and aggression, making the assessment of its validity and reliability essential. Since its development, the factor structure of the ICS has not been explored. To our knowledge, no study has tested a measurement model for the ICS using CFA (Brown, 2014), which helps researchers identify the best method for scoring the scale. Furthermore, because the ICS was designed to be sex neutral (Buunk & Fisher, 2009), we elected to conduct MGCFAs to assess the equivalence of a measurement model between the sexes. No study to our knowledge has sought to validate the ICS within a measurement model framework using SEM or

Table 5 Goodness-of-fit statistics for standardized and unstandardized regression coefficients for Models 5 and 6

Predictor		Outcome	*b*	*SE*	*p*	*β*
Model 5						
Sociosexual attitude	→	Inferiority frustration	− 0.19	0.06	.003	− 0.23
Sociosexual desire	→	Inferiority frustration	0.40	0.06	< .001	0.54
Sociosexual attitude	→	Superiority enjoyment	− 0.04	0.07	.56	− 0.05
Sociosexual desire	→	Superiority enjoyment	0.27	0.07	< .001	0.33
Inferiority frustration	→	Cost inflicting	0.31	0.02	< .001	0.73
Sociosexual attitude	→	Cost inflicting	− 0.05	0.02	.01	− 0.14
Sociosexual desire	→	Cost inflicting	0.07	0.02	< .001	0.21
Superiority enjoyment	→	Benefit provisioning	0.09	0.02	< .001	0.30
Sociosexual attitude	→	Benefit provisioning	0.03	0.02	.15	0.12
Sociosexual desire	→	Benefit provisioning	− 0.07	0.02	.001	− 0.28
Inferiority frustration	→	Partner upgrading	0.42	0.06	< .001	0.45
Superiority enjoyment	→	Partner upgrading	0.06	0.05	.17	0.07
Sociosexual attitude	→	Partner upgrading	0.01	0.05	.77	0.02
Sociosexual desire	→	Partner upgrading	0.25	0.05	< .001	0.37
Inferiority frustration	→	Mate seeking	− 0.09	0.09	.34	− 0.07
Superiority enjoyment	→	Mate seeking	0.32	0.08	< .001	0.29
Sociosexual attitude	→	Mate seeking	0.14	0.08	.09	0.14
Sociosexual desire	→	Mate seeking	0.11	0.08	.15	0.12
Model 6						
Inferiority frustration	→	Age at first sex	0.79	0.19	< .001	0.30
Superiority enjoyment	→	Age at first sex	− 0.20	0.17	.24	− 0.09
Sex	→	Age at FIRST sex	− 1.03	0.34	< .001	− 0.13
Inferiority frustration	→	Romantic partner number	− 0.05	0.01	< .001	− 0.24
Superiority enjoyment	→	Romantic Partner Number	0.04	0.01	< .001	0.22
Age	→	Romantic partner number	0.01	0.00	< .001	0.32
Inferiority frustration	→	Lifetime sex partners	− 0.09	0.02	< .001	− 0.35
Superiority enjoyment	→	Lifetime sex partners	0.05	0.02	< .001	0.21
Age	→	Lifetime Sex Partners	0.01	0.00	< .001	0.30
Inferiority frustration	→	Past-year sex partners	0.003	0.01	.68	− 0.03
Superiority enjoyment	→	Past-year sex partners	0.004	0.01	.54	0.05
Relationship status	→	Past-year sex partners	− 0.14	0.02	< .001	− 0.30
Inferiority frustration	→	Past-month sex	− 0.07	0.02	< .001	− 0.23
Superiority enjoyment	→	Past-month sex	0.03	0.02	.10	0.11
Relationship status	→	Past-month sex	− 0.58	0.06	< .001	− 0.45
Inferiority frustration	→	Relationship status	− 0.05	0.02	.01	− 0.19
Superiority enjoyment	→	Relationship status	0.01	0.02	.42	0.06

	χ^2	*df*	RMSEA	(90%CI)	SRMR	CFI	TLI
Model 5	2038.63	1005.00	0.05	0.05–0.06	0.08	0.905	0.898
Model 6	437.44	148.00	0.08	0.07–0.08	0.08	0.928	0.908

assessed whether ICS factors predict behavioral outcomes related to mating success.

Here, based on the results of Study 1 and Study 2A, it appears that a two-factor measurement model representing respondents' level of Inferiority Frustration and Superiority Enjoyment produces the best fit to the data. In addition to the tests of alternative models described in Study 2A, we employed a bi-factor model (Supplement 2) to test whether the two factors validated in Study 2A reflected two unique sources of variance. We elected to conduct this analysis because there are items in the ICS with different valences, leaving the possibility that our two-factor model was a result of method bias stemming from item wording (Brown, 2003). We found that a Superiority Enjoyment

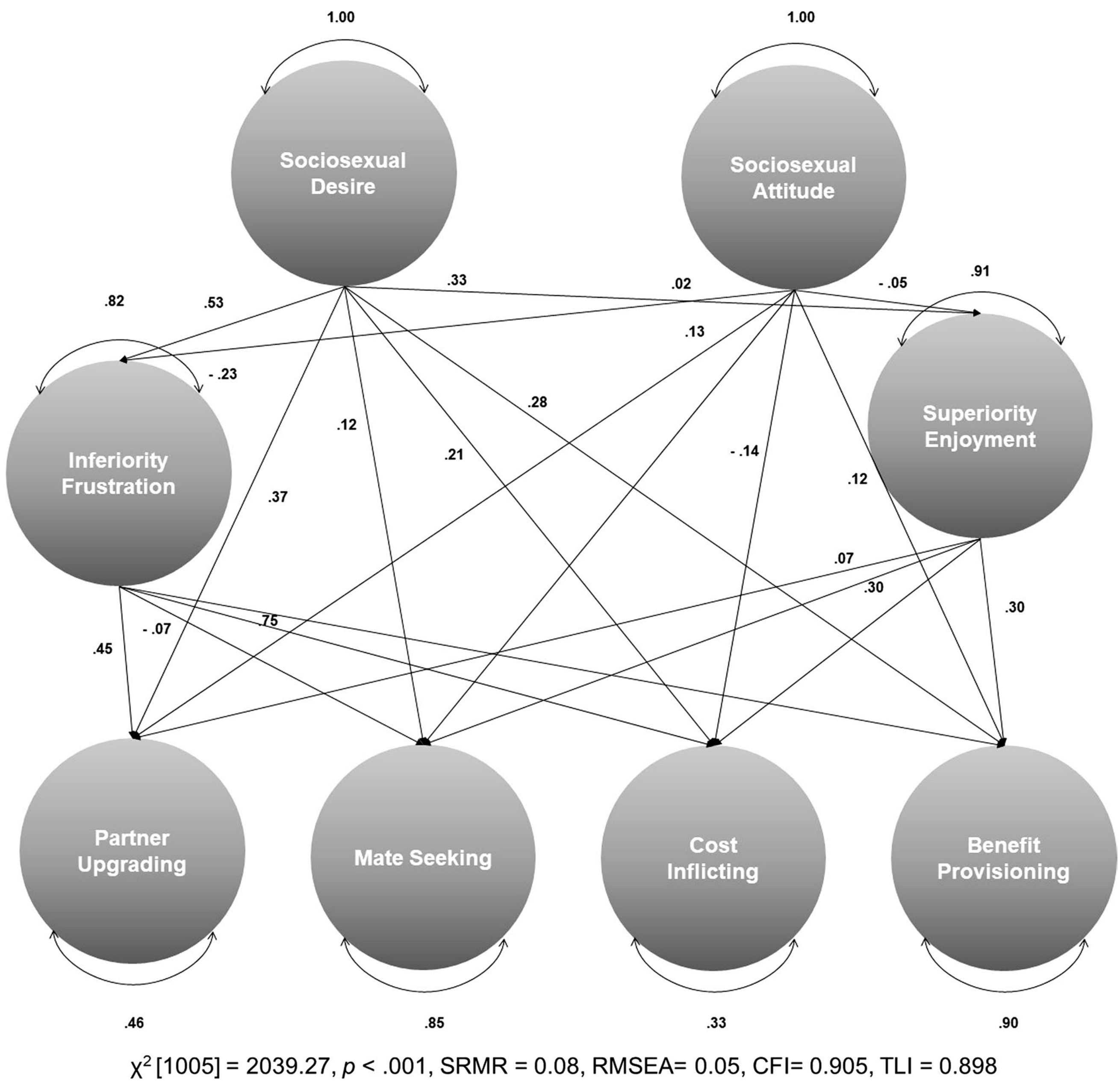

Fig. 2 Path diagram depicting Model 5. Note that the item loadings and residuals are standardized

factor provided a unique source of variance suggesting that the ICS is not unidimensional. Moreover, the general intrasexual competition factor and the specific factor representing Superiority Enjoyment had different correlates. From these results, we concluded that the general factor may be an empirical proxy for socially antagonistic or exploitative intrasexual competition that does not seem to contribute to mating success, whereas the specific factor, representing Superiority Enjoyment, may be a proxy for a more mutualistic approach to attracting and retaining mates. We concluded that there are two theoretically coherent ICS dimensions that provide unique information about individual differences in intrasexual competition as well as theoretically related constructs and outcomes.

We tested Model 4 for equivalence between the sexes. The model achieved metric invariance, as well as partial scalar and strict invariance. These findings provide some support for Buunk and Fishers' (2009) assertion that their scale measures constructs that have the same meaning across the sexes. Regarding the latent factors, males scored higher on Superiority Enjoyment, suggesting that although intrasexual

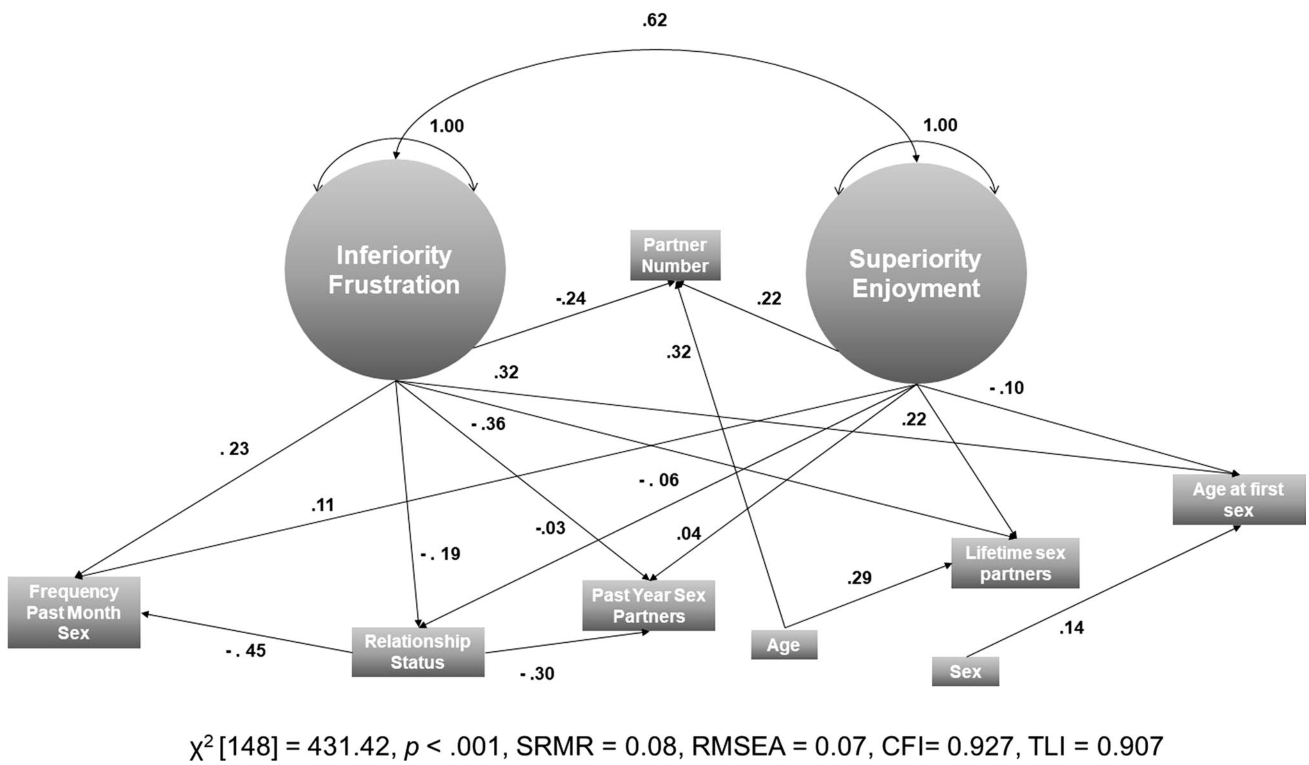

Fig. 3 Path diagram depicting Model 6. Note that the item loadings and residuals are standardized

Table 6 Means and standard deviations for the ICS, SOI-R, MRI-SF, and MEQ in Studies 1 and 2

	All		Men		Women	
	Mean	SD	Mean	SD	Mean	SD
Study 1						
ICS						
Superiority enjoyment	3.62	1.53	4.07	1.38	3.19	1.54
Inferiority frustration	2.66	1.43	2.94	1.40	2.38	1.41
Study 2						
ICS						
Superiority enjoyment	3.62	1.54	3.94	1.46	3.30	1.57
Inferiority frustration	2.76	1.49	2.92	1.48	2.61	1.49
SOI-R						
Attitude	4.73	2.40	5.23	2.37	4.21	2.33
Desire	3.73	2.17	4.59	2.16	2.86	1.81
Behavior	2.92	1.73	3.06	1.81	2.78	1.63
MRI-SF						
Cost-inflicting	1.64	0.70	1.73	0.73	1.54	0.66
Benefit provisioning	2.74	0.62	2.77	0.59	2.70	0.66
MEQ						
Partner upgrading	3.57	1.81	4.00	1.81	3.13	1.70
Mate seeking	4.03	1.50	4.29	1.47	3.76	1.48

competition manifests similarly in each sex, they do differ on one factor on average. Importantly, this mean sex differences in Superiority Enjoyment, but not Inferiority Frustration, provide additional evidence of the validity of the two-factor structure. A single-factor structure or score would have hidden this key difference between males and females.

Respondents' sexual desire was a significant positive predictor of both Superiority Enjoyment and Inferiority

Frustration, indicating that those who fantasize more about uncommitted sexual relations also experience a more competitive attitude toward same-sex individuals. Those individuals who had a more restricted sociosexual attitude also reported experiencing greater Inferiority Frustration and appeared to be worse prospective mates. Respondents who experienced greater Inferiority Frustration reported a greater willingness to try and attract an individual possessing a higher mate value partner when they were already mated (i.e., higher levels of partner upgrading) and reported using cost-inflicting mate retention behaviors more frequently (Albert & Arnocky, 2016; Buss et al., 2008). These findings fit within the broader framework of how intersexual competition relates to antisocial behavior (Arnocky et al., 2012; Carter et al., 2015; Lyons et al., 2019). Indeed, those that score higher on facets of the dark triad, a suite of personality characteristics measuring sub-clinical antisocial behavior, report higher levels of intrasexually competitive attitude (Lyons et al., 2019).

Regarding respondents' sexual behavior, those who reported higher Inferiority Frustration also reported a later age at first sexual intercourse, and fewer lifetime romantic and sex partners (controlling for age). Furthermore, individuals who reported higher Inferiority Frustration were also more likely to be single. These individuals also had intercourse less frequently, even after their relationship status was controlled. This would suggest that an attitude of frustration toward same-sex competitors may be in part rooted in individuals' actual experiences and failure at attracting mates. In contrast, those who reported greater Superiority Enjoyment also reported more total lifetime romantic and sex partners (controlling for age).

Limitations and Future Directions

This study has several limitations that can serve as the start point for future studies. First, we relied on self-reported measures, and as a result, error can be introduced during the retrieval processes involved with respondents' memory and with self-presentation bias. Second, recent research has highlighted that inattentive responding can negatively affect data quality (e.g., Fleischer et al., 2015). Although we recruited MTurk workers with a 95% approval rating, in future investigations it will be important to supplement online samples with laboratory samples. In future investigations, researchers should use both self-report and behavioral measures from respondents to validate the two-factor structure of the ICS. For example, researchers could conduct a competitive laboratory task, such as the Point-Subtraction-Aggression-Paradigm (Cherek, 1981) and evaluate whether respondents who score higher on Inferiority Frustration engage in more reactive aggression toward a same-sex competitor, compared to an opposite sex competitor.

The ICS was not designed specifically as a measure of attitude toward mating competition, but merely as a measure of attitude toward competition with same-sex individuals. Therefore, future investigations should seek to evaluate the concurrent validity of the scale by estimating its associations with related constructs outside of the domain of human mating. Moreover, we did not set out to confirm the discriminant validity of the ICS. Our finding of two factors suggests that future research should include more tests of the boundary conditions of Inferiority Frustration and Superiority Enjoyment. In particular, the literature on inter-individual differences in motivation, self-regulation, and personality suggest there are two distinct systems involved in responding to the presence of rewards and threats (e.g., the BAS and BIS systems; Carver & White, 1994). We predict that Inferiority Frustration will be more strongly linked to threat sensitivity, while more trivially correlated with reward sensitivity, while the reverse pattern will be observed for Superiority Enjoyment.

Future investigations could also seek to establish the concurrent and discriminant validity of the ICS factors using scales measuring constructs such as social comparison orientation (Gibbons & Buunk, 1999), competitiveness (Buunk & Gibbons, 2006) and jealousy (Arnocky et al., 2014a). Buunk and Fisher (2009) found that highly intrasexually competitive women reported high levels of social comparison, yet although intrasexually competitive attitude was related to variation in social comparison, it was distinct from the construct. Other investigations could benefit by including measures of respondents' reproductive success such as self-reported number of children and grandchildren.

Importantly, both factors of the ICS, Inferiority Frustration and Superiority Enjoyment could be a consequence of respondents' mating success rather than a cause. Rather than conceptualizing a top-down model in which intrasexually competitive attitude predict individuals' reproductive behavior, these factors may reflect individuals' attitudes toward competing for romantic partners, which have been affected by their reproductive success. In other words, Inferiority Frustration may not be a predictor of lesser mating success but may instead stem from the respondent experiencing lesser mating success. Researchers should control for participants' self-perceived mate value (Fisher et al., 2008) in their analyses because it could mediate the relationship between the ICS factors and reproductive success. By controlling for mate value and testing if Inferiority Frustration is either an outcome of, or a predictor for, respondents mating success researchers can better understand the extent to which intrasexually competitive attitude is dependent on respondents past mating success and their internal motivation to attract members of the opposite sex.

Here we have used sexual selection theory to make the prediction that people compete for mates and that some psychological process(es) motivate individuals to make decisions based on varying degrees of mating success. However, our view is that sexual selection theory, being on the ultimate level, cannot specify how many proximate common causes account for item response covariance. The number of dimensions can be derived from a consideration of the kinds of adaptive problems human intrasexual competitive attitude would need to solve. Individuals frequently interact with same-sex individuals whose mate value is either greater or lower than their own. Individuals could be more sensitive to positive and negative outcomes of their intrasexually competitive efforts. They may score highly on Superiority Enjoyment, but not Inferiority Frustration or vice versa and these scores may help us to understand their mating strategies. We contend that dimensionality is best determined via factor analysis, a bottom-up approach to determine a scales number of factors. Recall, Buunk and Fisher (2009) indicated that there were three minor factors with eigenvalues greater than one, raising the possibility that the ICS is not unidimensional. This motivated our investigation into the dimensionality of the ICS. We found that two factors provided a model with superior fit and captured more of the construct space. Future research should collect additional data, evaluate, and compare one and two-factor solutions to assess whether the two-factor solution found in the current study provides the best solution for scoring the ICS.

Conclusions

Female intrasexual competition is often overlooked when studying human mating behavior (cf. Arnocky et al., 2012; Vaillancourt & Sharma, 2011). Yet, both sexes compete for mates, although how they compete differs (e.g., Campbell, 1995; Davis et al., 2017; Fernandez et al., 2014; Wilson & Daly, 1985). They report engaging in intrasexual competition (Buss, 1988) and vary on intrasexually competitive attitude (Buunk & Fisher, 2009). Females compete for access to high-quality males that can provide them with access to economic resources whereas males compete for access to females with the capacity to produce healthy offspring (Atari et al., 2020; Buss, 1989; Castro & de Araújo Lopes, 2011; Eastwick & Finkel, 2008; Li & Kenrick, 2006; Li et al., 2002; Walter et al., 2020). Therefore, our conclusions that the ICS is best represented by two factors and that these factors predict individual differences in mating behaviors is important for both sexes. Based on our results, the ICS appears to be a reliable and valid measure of an important construct within the study of human mating—attitudes toward competing with same-sex others. This is one of few studies within the domain of mating psychology to report the confirmation of the factor structure of a measure and tests of measurement invariance and population heterogeneity within the same research report. Furthermore, our finding that the ICS may be best represented with two factors is novel and could provide researchers with a method for scoring the ICS that captures more information about respondents' sexual strategies. More research is required to determine the causal net connecting intrasexually competitive attitude and proxy measures of respondents' reproductive success.

Appendix

Item
1. I can't stand it when I meet another man/woman who is more attractive than I am. (IF)
2. When I go out, I can't stand it when women/men pay more attention to a same-sex friend of mine than to me. (IF)
3. I tend to look for negative characteristics in attractive men/women. (IF)
4. When I'm at a party, I enjoy it when women/men pay more attention to me than other men/women. (SE)
5. I wouldn't hire a very attractive man/woman as a colleague. (IF)
6. I just don't like very ambitious men/women. (IF)
7. I tend to look for negative characteristics in men/women who are very successful. (IF)
8. I wouldn't hire a highly competent man/woman as a colleague. (IF)
9. I like to be funnier and more quick witted than other men/women. (SE)
10. I want to be just a little better than other men/women. (SE)
11. I always want to beat other men/women. (SE/IF)
12. I don't like seeing other men/women with a nicer house or a nicer car than mine. (IF)

Items labeled with IF correspond to the Inferiority Frustration factor and the items labeled with SE correspond to the Superiority Enjoyment factor. To score the scale compute the means for each factor. Note that item 11 should be included in the computation of both factors

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10508-021-02167-6.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval This study was performed in line with the principles of the Declaration of Helsinki. All study procedures were approved by the Boston University Institutional Review Board.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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