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Disgust sensitivity predicts sociosexuality across cultures

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ABSTRACT

Restricted sociosexuality has been linked to sexual disgust, suggesting that decreasing sexual behavior may be a pathogen avoidance technique. Using the behavioral immune system framework, which posits that humans experience disgust after exposure to pathogen cues, we replicate and expand on previous studies by analyzing the influence of three domains of disgust (sexual, moral, pathogen) on psychological (desire and attitude) and behavioral domains of sociosexuality (SOI) in four diverse samples: American university students (n = 155), Salvadoran community members (n = 98), a global online sample (n = 359), and a four-country online sample (US, India, Italy, and Brazil; n = 822) collected during the SARS-CoV-2 pandemic. In contrast with previous studies, we account for shared variance in sexual, pathogen, and moral disgust by entering all three in a multiple regression to predict composite SOI. In both large samples, sexual disgust and pathogen disgust had opposing effects on composite SOI; that is, higher sexual disgust and lower pathogen disgust were associated with more restricted composite SOI. Additionally, we constructed a multi-group structural equation model (SEM) to determine the impact of each domain of disgust on each domain of SOI across all our samples simultaneously, while controlling for age and sex. Within this model we also assessed how the psychological domains of SOI – attitude and desire – mediate the relationship between disgust and sociosexual behavior. Pathogen disgust positively predicted SOI attitude and desire, but not behavior, consistently across all groups. SOI behavior was only predicted by pathogen disgust when mediated by SOI attitude, again across all groups, suggesting that behavior seems to be driven largely by the psychological facets of SOI. We discuss these findings in light of the behavioral immune system and the bet-hedging hypothesis, which make opposing predictions on the relationship between infection risk and sexual behavior.

1. Introduction

Researchers have proposed that humans evolved the ability to detect cues of infectious agents in the immediate environment (Curtis, 2014; Curtis, de Barra, & Aunger, 2011; Hlay et al., 2021; Hoben, Buunk, Fincher, Thornhill, & Schaller, 2010; Lieberman & Patrick, 2014; Murray, Jones, & Schaller, 2013; Murray & Schaller, 2010; Murray, Trudeau, & Schaller, 2011; Neuberg, Kenrick, & Schaller, 2011; Oaten, Stevenson, & Case, 2009; Schaller & Murray, 2008, 2012; Skolnick & Dzokoto, 2013; Tybur et al., 2016; Tybur & Lieberman, 2016; Tybur, Lieberman, & Griskevicius, 2009; Tybur, Lieberman, Kurzban, & Descioli, 2013). Detection of infection risk then triggers psychological shifts in disgust sensitivity, which motivate behaviors that reduce the risk of infection, including (1) avoiding contact with infectious agents (i.e., pathogen disgust); (2) promoting successful mating strategies by abstaining from partners who could decrease reproductive success (i.e., sexual disgust); and (3) evading individuals who violate social norms (i.e., moral disgust; but see Lieberman, Billingsley, & Patrick (2018) for a

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different partitioning of disgust). Together, this constellation of action is referred to as the "behavioral immune system" (BIS; Schaller & Park, 2011).

The BIS is thought to be adaptive in that it is designed to detect and avoid pathogens before infection, thus minimizing energetic demands associated with mobilizing the physiological immune system (Lochmiller & Deerenberg, 2000; McDade, 2003). Thus, the BIS predicts facultative adjustment of disgust sensitivity in line with infection risk; that is, when infection risk is higher (or perceived to be higher), disgust sensitivity should be upregulated (Hlay et al., 2021; Schaller & Park, 2011). Indeed, a previous study showed that those living in higher pathogen environments, as measured by both objective state-level infection mortality and perceived infection exposure, reported higher disgust sensitivity (Hlay et al., 2021). Further, objective infection mortality and perceived infection exposure were positively correlated, suggesting that individuals can track their environment's pathogen risk.

Sexual behaviors (e.g., kissing, intercourse) carry particularly high rates of exposure and may therefore be riskier when pathogen richness or transmissibility are high. Sexual contact not only increases exposure to sexually transmitted infections (STIs) like herpes, syphilis, chlamydia, and human immunodeficiency virus (HIV), but exposure to pathogens transmitted via direct contact of bodily fluids (Halperin & Epstein, 2004; Morris & Kretzschmar, 1997) and skin surfaces as well (Hunt et al., 2017). For example, several enteric, protozoan, and nematode parasites can be easily transferred through sexual activity via fecal-oral interfaces (Abdolrasouli, McMillan, & Ackers, 2009; Shelton, 2004). Further, protozoan parasites can be transmitted through sperm, which may cause infertility by damaging the reproductive organs (Crespillo-Andujar, Díaz-Menéndez, & Mora-Rillo, 2018). The fitness costs of these diseases may be very high (Lochmiller & Deerenberg, 2000), at least partly because they may cause sterility and death (Crespillo-Andujar et al., 2018; Schryver & Meheus, 1990).

In sum, BIS theory predicts that greater infection prevalence and risk should be associated with greater avoidance of high transmission behaviors such as sexual contact. Several previous studies have examined correlations between disgust sensitivity and sociosexual orientation, which includes attitudinal, desire, and behavioral components (Al-Shawaf, Lewis, & Buss, 2015; O'Shea, DeBruine, & Jones, 2019; Sevi, Aral, & Eskenazi, 2018); sociosexuality has been negatively correlated with sexual disgust levels across studies (Al-Shawaf, Lewis, & Buss, 2015; O'Shea et al., 2019). In other words, individuals are likely to report greater openness to casual sex if they score lower on sexual disgust. Furthermore, those who exhibit less sexual disgust and higher sociosexuality are more likely to use certain online dating apps that promote casual sex and short-term mating (Sevi et al., 2018). Evidence also suggests that germ averse behaviors (i.e., an indication of pathogen avoidance motivation; Gruijters, Tybur, Ruiter, & Massar, 2016) and higher worry about disease threat (Moran, Kerry, Goh, & Murray, 2021) may be related to lower number of sexual partners and restricted openness to casual sex. These findings are consistent with the theorythat high pathogen environments may influence sexual behavior via disgust sensitivity (Hlay et al., 2021).

Research suggests that disgust sensitivity and sociosexuality may differ among sexes. Women consistently score higher in disgust sensitivity across all domains—sexual, moral, and pathogen disgust (Al-Shawaf, Lewis, & Buss, 2015; Oaten et al., 2009; O'Shea et al., 2019; Tybur et al., 2009)—and also report engaging in a more restricted mating strategy (i.e., lower sociosexuality; Buss & Schmitt, 1993; Schmitt, Shackelford, & Buss, 2001; Schmitt, Shackelford, Duntley, Tooke, & Buss, 2001; Schmitt & International Sexuality Description Project, 2003). A central ultimate explanation for this sex difference is the asymmetrical burdens of parental investment (Trivers, 1972) and the risks of infection to the developing fetus (Al-Shawaf, Lewis, & Buss, 2018). However, in addition to these factors, the higher relative risk of infection for women may compound sex differences in disgust and sociosexuality. Women are disproportionately affected by STIs (The NIMH Collaborative HIV/STD Prevention Trial Group, 2010) and are more likely to be asymptomatic (World Health Organization, 2016) and have complications (Mohllajee, Curtis, & Peterson, 2006), which can increase disease progression and rates of infertility (Atalabi, Fayemiwo, Oladokun, & Bakare, 2013; Okonofua, Snow, Alemnji, Okoruwa, & Ijaware, 1997; Sameni, Zadeh Modarees, & Dabiri, 2017). Therefore, heightened sexual disgust sensitivity and a more restricted, choosier mating strategy may enable women to better to avoid potentially infectious sexual partners and thereby infection (Lieberman et al., 2018; Murray et al., 2013). In contrast to women, men may face fewer risks with increasing sexual partners (e.g., less obligate parental and energetic investment, Trivers, 1972; lower risk of STI contraction, The NIMH Collaborative HIV/STD Prevention Trial Group, 2010), and this may explain their lower average disgust sensitivity and less restricted mating strategy (Buss & Schmitt, 1993; Schmitt & International Sexuality Description Project, 2003; Schmitt, Shackelford, & Buss, 2001; Schmitt, Shackelford, Duntley, et al., 2001).

1.1. The current research

Although past studies have explored the relationship between disgust sensitivity and sociosexuality, substantial gaps in our understanding remain. First, past studies have examined only *composite* sociosexuality scores; that is, a single score summarizing attitude, desire, and behavior toward casual sex (Al-Shawaf, Lewis, & Buss, 2015; O'Shea et al., 2019; Sevi et al., 2018). The most widely used measure of sociosexuality, the Sociosexual Inventory – Revised (SOI-R; Penke & Asendorpf, 2008), accounts for three domains—*attitude* toward unrestricted sex, *desire* for unrestricted sex, and unrestricted sexual *behavior*. Because these domains are theoretically and statistically distinct (Penke & Asendorpf, 2008), it is unclear if disgust sensitivity is differentially (or equally) associated with them. This seems plausible given a large literature implicates attitudes and intentions in behavioral outcomes (e.g., see McEachan, Conner, Taylor, & Lawton, 2011), suggesting that many constructs may impact SOI-R behavior indirectly through SOI-R attitude and desire. Importantly, differential associations between disgust and individual SOI-R facets would imply that a single SOI-R summary score is not sufficient (i.e., information is lost when a single score is used). Additionally, it seems plausible that the associations among disgust and SOI-R domains could vary across cultures; for example, cultural norms or laws could moderate associations with the behavioral domain to a greater degree than associations with desire (Schmitt, 2005). Analyzing the independent impact of each domain separately would provide additional evidence contraindicating use of a single SOI-R score. To account for these possibilities, we estimate relationships between disgust sensitivity and each SOI-R domain separately. In addition, we test whether the psychological domains of SOI (attitude and desire) mediate the relationship between disgust sensitivity and sociosexual behavior across cultures. We model these relationships to better understand the downstream effects of disgust sensitivity on individual differences in SOI attitude and desire, which should precede sexual behavior.

Second, the analyses employed by O'Shea et al. (2019) and Al-Shawaf, Lewis, Alley, and Buss (2015) did not account for the shared variance among the three domains of disgust—sexual, moral, and pathogen (Sherlock, Zietsch, Tybur, & Jern, 2016; Tybur et al., 2009). This seems important given at least one study has shown that including all domains of disgust in the model can change the direction of the relationship between disgust domains and an outcome variable (Billingsley, Lieberman, & Tybur, 2018). Therefore, we examine the unique variance in each domain of disgust associated with each domain of the SOI-R (i.e., behavior, attitude, and desire). Additionally, we focus on pathogen and sexual disgust domains because casual sexual behavior is likely to be most influenced by pathogen and sexual cues related to potential contamination (Curtis et al., 2011; Curtis & Biran, 2001; Gruijters et al., 2016; Lieberman & Patrick, 2018; Schaller & Murray, 2008; Schmitt,

2005; Tybur, Merriman, Caldwell Hooper, McDonald, & Navarrete, 2010).

Third, the generalizability of the relationship between disgust sensitivity and sociosexuality across ages, cultures, economic development, and disease ecology remains in question. Al-Shawaf, Lewis, Alley, and Buss (2015) used a sample of university students from Texas, and although O'Shea et al. (2019) and Sevi et al. (2018) used larger online samples, the demographics of ethnicity, identity, or country of residence were not reported. Various cultural and ecological differences between sampling locations could affect sexual behavior, as could age (Schmitt, 2005; Schmitt & International Sexuality Description Project, 2003). For example, evidence suggests that those with more conservative beliefs (Billingsley et al., 2018; Tybur et al., 2010; Tybur, Inbar, Güler, & Molho, 2015) are less open to casual sex. Population differences in sociosexuality may also be affected by the degree of pathogen risk in the local environment; several studies have shown that higher environmental pathogen load is associated with less openness to others (Aarøe, Osmundsen, & Petersen, 2016; Navarrete & Fessler, 2006; Reid et al., 2012; Schaller & Murray, 2008), lower sociality (Fincher, Thornhill, Murray, & Schaller, 2008; Thornhill & Fincher, 2014), and restricted sociosexuality (Barber, 2008), all of which may decrease the number of sexual encounters. Finally, socioeconomic and energetic burdens may alter the relative benefits of disgust; for instance, one study found that short-term increases in energy output were associated with decreases in disgust levels (Batres & Perrett, 2020). These results suggest that disgust levels may fluctuate in different environments, further demonstrating the value of samples from different populations. To this end, we use four independent samples—a university sample from the US (n = 155), a mixed-age Salvadoran sample (n = 98), and two mixed-age global online samples (n = 359; n = 822)—to evaluate the invariance of the disgust-SOI relationships across populations.

Our study aims to fill the aforementioned gaps in knowledge about relationships between disgust sensitivity and sociosexual orientation. Based on theory and existing evidence, we hypothesize that: (H1) women will report significantly higher disgust sensitivity across all three domains and more restricted sociosexuality (e.g., lower scores on the SOI-R); (H2) more restricted composite sociosexuality will correlate with higher reported sexual disgust sensitivity (i.e., we conduct a direct replication of Al-Shawaf, Lewis, Alley, & Buss, 2015, before proceeding with all three SOI-R facet scores); (H3) higher reported sexual and pathogen disgust sensitivity will be related to more restricted sociosexual attitude, desire, and behavior; and (H4) SOI attitude and desire will mediate effects of pathogen and sexual disgust domains on SOI behavior.

2. Methods

2.1. Participants

All procedures were approved by Boston University Institutional Review Board. After providing informed consent, all participants completed a questionnaire via Qualtrics as part of a larger study on health and human behavior.

2.1.1. University in-person sample

We recruited 166 students at Boston University in 2017 via advertisements placed in common areas throughout the campus and through online job adds for Boston University students. After accounting for cases missing more than 5% of data, there were 157 participants (14 women) included in the analyses. The participants ranged in age from 18 to 40 years old (M_{age} = 21.20, SD = 2.80) and self-identified as White (40.5%), Asian (19.0%), South Asian (14.9%), Latin American (10.7%), Black (7.4%), Arab West Asian (4.1%), and South East Asian (1.7%). Participants were compensated 35.00 USD after completing the study.

2.1.2. Salvadoran in-person sample

We recruited 101 participants from El Salvador in the summer of 2019 at a university in the municipality of Santa Tecla, although participants did not have to be students at the university to participate. After accounting for cases missing more than 5% of data, there were 97 participants (58 women) included in the analyses. The participants ranged in age from 18 to 48 years old (M_{age} = 23.68, SD = 7.40). Most participants self-identified as Latin American (88%) or White (8%); fewer (< 1% each) identified as Asian, South East Asian, Arab West Asian, or Indigenous. Participants were compensated 3.00 USD after completing the study.

2.1.3. Global online sample

We recruited 361 online participants (175 women) from Amazon's Mechanical Turk (MTurk) in 2018. The participants ranged in age from 18 to 63 years old (M_{age} = 26.12. SD = 5.50). Participants were from 23 countries[1]; the two largest groups were from India (22.8%) and the US (40.3%). Participants were compensated 1.50 USD after completing the study.

2.1.4. Four-country online sample

We recruited 1495 online participants using MTurk during the first week of April 2020. After accounting for failed attention checks, repeat IP addresses, and participants missing more than 5% of data, 817 participants (258 women) remained. The participants ranged in age from 18 to 72 years old (M_{age} = 31.55, SD = 9.91); 210 (67 women) were from Brazil, 204 (44 women) were from India, 178 (57 women) were from Italy, and 225 (90 women) were from the US. These countries were chosen to be diverse in culture (e.g., conservatism; Stankov, Lee, & van de Vijver, 2014), and general infection (Global Burden of Disease Collaborative Network, 2018) and SARS-CoV-2 prevalence (Coronavirus Cases Worldwide by Country, 2020). In particular, India and Brazil are relatively low-income countries when measured by GDP per capita (worldbank.org, 2019) and high in historical and current infectious disease prevalence (Global Burden of Disease Collaborative Network, 2018; Murray & Schaller, 2010), while the US and Italy are relatively high-income countries with low disease prevalence.

2.2. Measures

2.2.1. Sociosexuality

High scores on the revised Sociosexual Orientation Inventory (SOI-R) indicate individuals are comfortable engaging in uncommitted sexual relationships, whereas low scores indicate that individuals prefer committed relationships prior to intercourse (Penke & Asendorpf, 2008). The SOI-R includes nine items that measure past sexual behavior (e.g., "With how many different partners have you had sex within the past 12 months?"), attitude toward non-committal sex (e.g., "Sex without love is ok."), and sociosexual desire (e.g., "How often do you have fantasies about having sex with someone you are not in a committed romantic relationship with?"). Correlations among domains were under r = 0.52 and variance inflation factors were under 1.875, indicating multicollinearity among disgust factors was not likely high enough to inflate standard errors in any sample. Participants responded using a 9-point Likert-type rating scale. We summed the three items under each of the domains separately to yield separate scores for behavior, attitude, and desire, which were then summed to yield a composite sociosexuality score (cf., Al-Shawaf, Lewis, Alley, & Buss, 2015; O'Shea et al., 2019; Sevi et al., 2018). For the current study, α levels were 0.70 (attitude), 0.88 (behavior), and 0.89 (desire).

2.2.2. Three Domains of Disgust Scale

The Three Domains of Disgust Scale (TDDS; Tybur et al., 2009) contains 21 items and uses a 7-point Likert-type scale (0 = "not at all disgusting" to 6 = "extremely disgusting") to rate pathogen, sexual, and moral disgust. In previous studies the scale has shown a coherent factor

structure (Tybur et al., 2009), and has been administered to diverse, global samples (Tybur et al., 2016). Example items for each domain include "stepping on dog poop" (pathogen disgust), "watching a pornographic video" (sexual disgust), and "stealing from a neighbor" (moral disgust). Correlations among domains were under 0.58 and variance inflation factors were under 1.875, indicating multicollinearity among disgust factors was not high enough to inflate standard errors in any sample. We summed the seven items under each domain to give each participant three separate scores. For the current study, α levels ranged from 0.83 (pathogen), 0.86 (sexual), and 0.87 (moral).

2.3. Data analysis

We used multi-group structural equation modeling (SEM) to test most of our hypotheses because it allowed us to (1) test parameters across all our samples and countries simultaneously to determine if they were invariant or should be estimated separately by group; (2) determine if group differences in sociosexuality (SOI) could be attributed, in part, to age, sex, and facets of disgust; and (3) test indirect effects of disgust facets on SOI behavior via SOI attitude and desire. We used the MPlus 8 software package, the maximum likelihood (ML) estimator, and conducted significance testing at the conventional $\alpha = 0.05$ level. When examination of group mean differences was not as straightforward within the multi-group SEM (e.g., when we tested mean sex differences in SOI domains to address H1), we used SPSS 25 to conduct Welch's *t*-tests (to account for unequal sub-sample sizes) and Cohen's *d* to examine the magnitudes of sex differences in disgust and SOI. We also used an ANOVA with Tukey's post-hoc tests to test for country-level differences in the four-countries sample. Additionally, we tested for pre- versus during-SARS-CoV-2 pandemic effects (the global online sample compared to the four-country online sample), also using *t*-tests and Cohen's *d*. Finally, we tested H2 using SPSS 25 and a regression model that mirrored those used by Al-Shawaf, Lewis, Alley, and Buss (2015) in an effort to replicate their results; that is, we used separate regressions to assess how composite SOI and sex predicted each domain of disgust. Additionally, we analyzed a multiple regression to assess how each domain of disgust predicted composite sociosexuality.

2.3.1. Model fit

In our multi-group SEM analyses, we used a variety of fit indices because they provide different information about model fit. We considered the substantive meaningfulness of the model, non-significance of the χ^2 likelihood ratio statistic (Bollen, 1989), comparative fit index (CFI) values greater than or equal to 0.95 (Hu & Bentler, 1999), and root means square error of approximation (RMSEA) values of less than or equal to 0.05 (Browne & Cudeck, 1992) as evidence of acceptable fit to the data.

3. Results

The total analytic sample size was $n = 1432$ and the group-specific sizes were: $n_{\text{Brazil}} = 210$, $n_{\text{India}} = 204$, $n_{\text{Italy}} = 178$, $n_{\text{USA}} = 225$, $n_{\text{university}} = 157$, $n_{\text{global online sample}} = 361$, and $n_{\text{El Salvador}} = 97$. We began by testing the model for functional invariance to determine if parameters varied significantly by group and should be estimated separately. First, we imposed equality constraints on the effects of sex, age, sexual disgust, moral disgust, and pathogen disgust on the three sociosexuality (SOI) domains. These constraints produced a model (1A) that did not fit the data well ($\chi^2 = 364.743[90]$, $p < .001$; CFI = 0.889; RMSEA = 0.122 [0.109–0.135]), suggesting the parameters we constrained were not equal across all the groups; thus, we observed modification indices (MIs > 10) to identify parameters that should be freed in particular groups. We freed the effects of sexual disgust on SOI attitude and behavior in El Salvador; the effects of sex and pathogen disgust on SOI desire as well as the effect of sexual disgust on SOI attitude in India; the effect of pathogen disgust on SOI attitude in the US; the effect of pathogen disgust on SOI attitude in the global online sample; and the effect of sex on SOI behavior and the effect of sexual disgust on SOI desire in Brazil. Freeing these nine parameters produced a model (1B) that fit the data well ($\chi^2 = 143.295[81]$, $p < .001$; CFI = 0.975; RMSEA = 0.061[0.044–0.078]). We observed that MIs revealed no additional sources of strain (all MIs < 10).

Next, we imposed equality constraints on the effects of sex and age on the three disgust domains (model 2A) and found that these constraints worsened fit substantially (ΔCFI = −0.02; $\chi^2 = 228.369[117]$, $p < .001$; CFI = 0.955; RMSEA = 0.068[0.055–0.081]). On the basis of relatively large MIs (i.e., > 10), we freed the effect of sex on sexual disgust in El Salvador. We also found a relatively large MI emerged for the effect of sexual disgust on SOI behavior in Italy and freed this parameter as well. Freeing these two parameters produced a model (2B) that did not fit substantially worse than model 1B but estimated 31 fewer parameters (ΔCFI = −0.008; $\chi^2 = 197.613[115]$, $p < .001$; CFI = 0.967; RMSEA = 0.059[0.045–0.073]). Retaining this model, we then imposed equality constraints on the effects of SOI-R attitude and desire on SOI-R behavior. The fit of this model was not adequate ($\chi^2 = 284.821[127]$, $p < .001$; CFI = 0.936; RMSEA = 0.078[0.066–0.090]). Based on the observed MIs, we freed the effect of SOI desire on SOI behavior in El Salvador, India, India, and the US. Doing so produced a model (3A) that did not fit substantially worse than 2B but estimated eight fewer parameters (ΔCFI = 0.000; $\chi^2 = 203.467[123]$, $p < .001$; CFI = 0.967; RMSEA = 0.057[0.042–0.070]).

Finally, we tested scalar invariance (i.e., equality of intercepts) for the SOI domains across the groups to determine whether mean differences across them could be attributed, in part, to disgust facets, sex, and age. The fit of the resulting model (4A) was poor ($\chi^2 = 512.586[141]$, $p < .001$; CFI = 0.850; RMSEA = 0.114[0.103–0.124]). Based on relatively large MIs, we freed all three intercepts in El Salvador and India; the SOI behavior and attitude intercepts in the US and the global online sample; and the SOI behavior intercept in Brazil. Doing so produced a model (4B) that fit the data slightly better than 3A (ΔCFI = 0.005; $\chi^2 = 198.923[129]$, $p < .001$; CFI = 0.972; RMSEA = 0.051[0.037–0.065]).

After retaining model 3A, we interpreted parameter differences across the groups. Overall, we observed a strong degree of invariance. Eighteen (69%) of the 26 parameters we tested for equality were fully invariant across all the groups. Furthermore, only three of the eight parameters that were not fully invariant required more than two group-specific estimates. That is, estimates of all parameters were not statistically indistinguishable across at least five of the seven groups. Another way of thinking about this is that freely estimating all 26 parameters in seven groups would require 182 group-specific estimates, but we only needed 28 (15%). As mentioned, three parameters did exhibit a larger degree of non-invariance across the groups. The effect of SOI desire on behavior was invariant across Brazil, the US university sample, and the global online sample; but was uniquely estimated in India, Italy, USA, and El Salvador. The intercept for SOI attitude was only invariant across Brazil, Italy, and the US university sample; while the intercept for SOI behavior was only invariant across Italy and the US university sample. The non-invariance of these intercepts meant that between-group differences in SOI attitude and behavior could not be attributed to group differences in disgust. The SOI desire intercept was largely invariant across the groups (i.e., in all but India and El Salvador), group differences in desire could be attributed, in part, to group differences in disgust; however, the effects of disgust facets on desire were too small to be practically important.

Twelve effects appeared universal—the effect of pathogen disgust on SOI behavior; the effects of moral disgust on all three SOI domains; the effects of sex on pathogen disgust and moral disgust; and all six effects of age. Moreover, the effect of sex on SOI behavior was invariant across all groups except Brazil, the effect of sex on SOI desire was invariant across all groups except India and El Salvador, the effect of sex on SOI attitude was invariant across all groups except the US, and the effect of sex on sexual disgust was invariant across all groups except El Salvador.

Therefore, evidence suggests that sex differences in the SOI and disgust domains (and absences thereof) were nearly universal across the groups.

To evaluate the consistency of the evidence with our hypotheses, we sought to interpret the parameters in terms of significance and magnitude, both of which can vary by group despite equivalence of unstandardized effects when group differences exist in the variances. The relative importance of sex, for instance, can vary by group although the mean sex difference itself does not. But before turning to hypothesized effects, we first examined age differences, differences between our pre-SARS-CoV-2 pandemic and during-pandemic samples, and between country differences in the disgust and SOI domains.

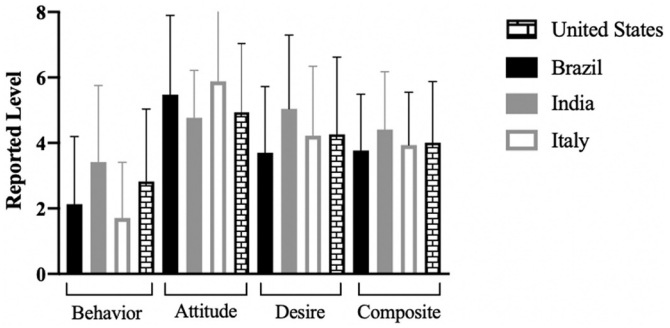

Fig. 1. Coutry differences in sociosexuality.

3.1.1. Age, pre- and during-pandemic, and country differences

Age effects on moral (βs = 0.05 to 0.19) and pathogen (βs = 0.03 to 0.12) disgust were significant, small, and positive across the groups; and the age effect on sexual disgust was non-significant across them. Age effects on SOI attitude were significant, small, and negative (βs = −0.03 to −0.19) across the groups. Age effects on SOI behavior were significant, small, and positive (βs = 0.03 to 0.12) across the groups. Age effects on SOI desire were non-significant in all groups except the university sample (βs = −0.02). Taken together, these findings suggested older participants experienced greater moral and pathogen, but not sexual, disgust; as well as more negative SOI attitude, more positive SOI behavior, and no difference in SOI desire.

Using SPSS, we also assessed differences between our pre-SARS-CoV-2 pandemic sample compared to our during-pandemic sample. Pathogen disgust and sociosexual behavior are lower in the four-country online sample, which was taken during the pandemic. No other differences were significant. See all results in Table S1. In the four-country online sample, we also analyzed country differences in disgust and SOI. For differences in disgust, please refer to Fig. 8 in Hlay et al. (2021), which showed significantly lower levels of sexual disgust, yet higher moral disgust, in Italy and Brazil compared to the US and India and no differences between countries in pathogen disgust. There were also significant differences between countries in all domains of SOI (behavior: [F(3) = 25.24, $p < .01$]; attitude: [F(3) = 11.38, $p < .01$], desire: [F(3) = 13.28, $p < .01$]), as well as composite SOI [F(3) = 1.96, $p < .01$]. Tukey's post-hoc tests revealed that all countries' mean SOI behavior significantly differed from each other, except Brazil and Italy ($Brazil_M = 2.13$, $SD = 2.07$; $India_M = 3.41$, $SD = 2.34$; $Italy_M = 1.71$, $SD = 1.70$; $US_M = 2.82$, $SD = 2.21$; $ps < 0.02$, who reported less restricted SOI behavior than the US and India. All countries' mean SOI attitude significantly differed from each other, except Brazil with Italy, and India with the US ($Brazil_M = 5.48$, $SD = 2.42$; $India_M = 4.77$, $SD = 1.45$; $Italy_M = 5.89$, $SD = 2.39$; $US_M = 4.94$ $SD = 2.10$; $ps < 0.04$). India was significantly higher and Brazil was significantly lower in mean SOI desire compared to the US and Italy ($Brazil_M = 3.69$, $SD = 2.02$; $India_M = 5.04$, $SD = 2.25$; $Italy_M = 4.23$, $SD = 2.12$; $US_M = 4.27$, $SD = 2.35$; $ps < 0.03$). For composite SOI, Brazil and Italy were significantly lower than India ($Brazil_M = 3.77$, $SD = 1.72$; $India_M = 4.41$, $SD = 1.77$; $Italy_M = 3.94$, $SD = 1.61$; $US_M = 4.01$, $SD = 1.87$; $ps < 0.04$). See Fig. 1.

H1. Women will report higher sexual, pathogen, and moral disgust and men will report less restricted sociosexuality.

Turning to sex (0 = male, 1 = female), our multi-group SEM results indicated its effect on sexual disgust was significant, small, and positive (βs = 0.14 to 0.20) across all groups except El Salvador, in which the effect was large and positive (βs = 0.62). The sex effects on moral disgust (βs = 0.07 to 0.13) and pathogen disgust (βs = 0.10 to 0.21) were significant, small, and positive across all groups. In line with Al-Shawaf, Lewis, Alley, and Buss (2015), these findings indicate females reported modestly higher disgust across all groups except El Salvador, where they exceeded males by a larger degree.

In our multi-group SEM, the disgust facets were controlled in the equations for SOI attitude, desire, and behavior. Examining sex differences in these domains and how they varied by group was less straightforward because sex could have direct and indirect effects on SOI facets. Therefore, we used SPSS to test for mean sex differences in the SOI facets. We found that in the Salvadoran in-person and four-country online sample, men reported significantly less restricted SOI across all domains. In the global online sample, men reported significantly less restricted composite SOI and SOI desire. All results may be found in Table 1.

H2. More restricted composite sociosexuality will relate to higher reported sexual disgust sensitivity.

To directly replicate the analyses of previous studies (Al-Shawaf, Lewis, Alley, & Buss, 2015; O'Shea et al., 2019; Sevi et al., 2018), we used SPSS to conduct a multiple regression in which composite SOI scores and sex predicted sexual disgust. In the US university ($b = -0.22$, SE = 0.05, $\beta = -0.33$, $p < .01$) and Salvadoran ($b = -0.51$, SE = 0.11, $\beta = -0.37$, $p < .01$) in-person samples, composite SOI scores negatively predicted sexual disgust sensitivity. See Table S2 for all results. In contrast to the in-person samples, and to Al-Shawaf, Lewis, Alley, and Buss (2015) and O'Shea et al. (2019), the model predicting sexual disgust sensitivity from composite SOI and sex was not significant in either the global or the four-country online samples. See Table S2.

H3. Higher reported disgust sensitivity will be related to more restricted sociosexuality across all domains.

3.1.2. Composite sociosexuality

In a multiple regression model that included all domains of disgust, as well as age and sex, predicting composite sociosexuality, sexual disgust sensitivity was a significant negative predictor across all samples ($b = -0.53$ – -0.22, SE = 0.05–0.14, $\beta = -0.46$ – -0.18, $p < .01$), in line with our hypothesis. However, pathogen disgust sensitivity was a *positive* predictor in both online samples (Global: $b = 0.23$, SE = 0.1, $\beta = 0.15$, $p = .02$; Four-countries: $b = 0.21$, SE = 0.07, $\beta = 0.15$, $p < .01$). Moral disgust sensitivity was not a significant predictor in any group except in the four-country online sample ($b = 0.22$, SE = 0.06, $\beta = 0.17$, $p \leq 0.01$). See **Table S3** for all results.

3.1.3. Sociosexual attitude

Across all groups, pathogen disgust significantly and positively predicted SOI attitude. Effects ranged from small to moderate in magnitude (β = 0.06–0.40). In line with our hypothesis, sexual disgust significantly and negatively predicted SOI attitude in all groups except India. Effects ranged from moderate to large in size (β = −0.60 – -0.33). Moral disgust did not significantly predict SOI attitude. See Table 1 for all results.

3.1.4. Sociosexual desire

Moral disgust (β = 0.05–0.07) had significant but small positive effects on SOI desire in Italy, the global online sample, and El Salvador;

Table 1
El Salv = El Salvador group; US Uni = US university group; Standardized *b* (SD), *$p < .05$, ** $p < .01$, *** $p < .001$; Model fit: RMSEA = 0.05, CFI = 0.97, TLI = 0.96, SRMR = 0.07.

	In-Person Samples		Online Samples				
				Four Countries Sample			
Parameter	US Uni	El Salv	Global	Brazil	India	Italy	US online
SOI behavior							
Sexual disgust	0.17(0.03)***	−0.35(0.10)***	0.23(0.04)***	0.21(0.03)***	0.19(0.03)***	0.08(0.05)	0.21(0.04)***
Moral disgust	−0.02(0.02)	−0.02(0.03)	−0.02(0.03)	−0.02(0.03)	−0.02(0.03)***	−0.02(0.03)	−0.02(0.03)
Pathogen disgust	−0.05(0.03)	−0.06(0.03)	−0.05(0.03)	−0.05(0.03)	−0.05(0.03)	−0.05(0.03)	−0.05(0.03)
Sex	0.002(0.02)	0.01(0.04)	0.004(0.03)	−0.28(0.05)***	0.003(0.02)	0.004(0.03)	0.004(0.02)
Age	0.03(0.01)***	0.12(0.03)***	0.07(02)***	0.08(0.02)***	0.05(0.01)***	0.12(0.03)***	0.12(0.03)***
SOI attitude							
Sexual disgust	−0.41(0.04)***	−0.33(0.11)***	−0.53(0.03)***	−0.50(0.04)***	−0.003(0.10)	−0.50(0.04)***	−0.60(0.04)***
Moral disgust	0.05(0.03)	0.09(0.06)	0.05(0.03)	0.05(0.03)	0.08(0.05)	0.04(0.03)	0.06(0.04)
Pathogen disgust	0.06(0.03)*	0.13(0.06)*	0.23(0.05)***	0.07(0.03)*	0.12(0.06)*	0.06(0.03)*	0.40(0.06)***
Sex	−0.02(0.02)	−0.08(0.06)	−0.03(0.02)	−0.03(0.02)	−0.04(0.03)	−0.03(0.02)	−0.19(0.05)***
Age	−0.03(0.01)***	−0.19(0.05)***	−0.06(0.02)***	−0.07(0.02)***	−0.09(0.02)***	−0.10(0.02)***	−0.13(0.03)***
SOI desire							
Sexual disgust	−0.04(0.03)	−0.05(0.03)*	−0.05(0.03)	−0.24(0.05)***	−0.05(0.03)	−0.04(0.03)	−0.05(0.03)
Moral disgust	0.06(0.03)*	0.05(0.04)*	0.07(0.03)*	0.07(0.04)*	0.06(0.03)*	0.06(0.03)*	0.07(0.04)*
Pathogen disgust	0.07(0.03)*	0.06(0.02)*	0.07(0.03)*	0.08(0.04)*	0.53(0.07)***	0.07(0.03)*	0.07(0.03)*
Sex	−0.18(0.03)***	−0.33(0.04)***	−0.29(0.03)***	−0.29(0.03)***	−0.04(0.05)	−0.29(0.03)***	−0.27(0.03)***
Age	−0.03(0.01)	−0.05(0.02)	−0.03(0.02)	−0.04(0.02)	0.03(0.02)	−0.06(0.03)	−0.06(0.03)

while pathogen disgust had small positive effects (β = 0.06–0.08) on this outcome across all groups except India, in which it had a large positive effect (β =0.53). By contrast, sexual disgust only had a significant, but small and negative, effect on SOI desire in Brazil (β = −0.24). See Table 1 for all results.

3.1.5. Sociosexual behavior

Across all groups except Italy, sexual disgust significantly predicted SOI behavior. Effects ranged from small to moderate in size (β = |0.23| - |0.35|). Notably, sexual disgust was a positive predictor, except in the Salvadoran sample, in which sexual disgust was a negative predictor, as hypothesized (β = −0.35). Neither pathogen nor moral disgust directly predicted SOI behavior. See Table 1 for all results.

H4. The effects of sexual and pathogen disgust on sociosexual behavior will be mediated by sociosexual attitude and desire.

To test hypothesis 4, we used our multi-group SEM to estimate indirect effects of the disgust domains on SOI-R behavior via SOI-R attitude and desire. In all groups except India, SOI attitude appeared to significantly mediate the negative effect of sexual disgust on SOI behavior (indirect: β = −0.16 – -0.05). In only Brazil, SOI desire also appeared to mediate this effect (β = −0.07). Across all groups, SOI attitude appeared to mediate the positive effect of pathogen disgust on sociosexual behavior (β = 0.02–0.10). Additionally, in all groups except El Salvador and Italy, sociosexual desire also appeared to mediate this effect (β = 0.02–0.31). See all results in Fig. 2 and Table 2.

4. Discussion

The goal of the current study was to build on previous work suggesting an evolved relationship between disgust (an emotion to promote pathogen avoidance) and potentially pathogen-risky sexual behavior. The collective results from this study provide the following takeaways: (1) While sex differences in sexual disgust were present across samples, sex differences in moral and pathogen disgust were only present in the larger, online samples. (2) In multiple regression analyses that include all domains of disgust to account for their shared variance, sexual disgust negatively predicted composite SOI across all four samples, while pathogen and moral disgust *positively* predicted SOI in our larger, more diverse samples. Furthermore, these effects were largely due to the

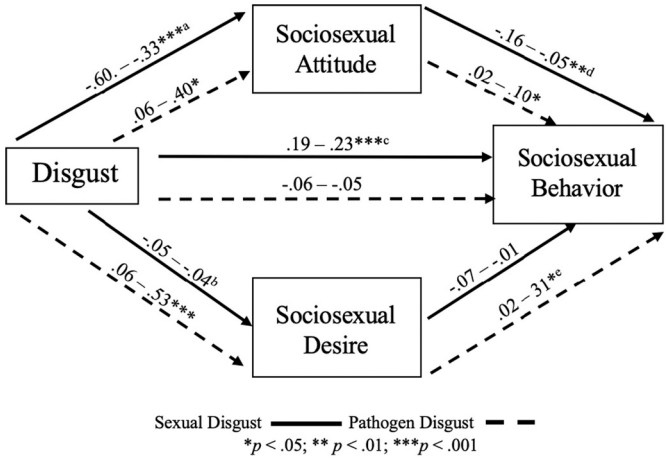

Fig. 2. Trends across groups where sociosexual attitude and desire mediate the relationship between disgust and sociosexual behavior. Note. [a]excludes India; [b]excludes El Salvador and Brazil, which had significant effects; [c]excludes El Salvador and Italy samples; [d]excludes Italy; [e]excludes El Salvador and Italy.

associations between disgust and the psychological domains of SOI (attitude and desire), as demonstrated in our multi-group model. Individuals with lower sexual disgust, but higher pathogen and moral disgust, have more favorable attitudes toward and greater desire for uncommitted sex. (3) Further, SOI attitude mediated the negative relationship between sexual disgust and SOI behavior across most samples, while SOI desire and attitude mediated the positive relationship between pathogen disgust and SOI behavior. This is consistent with our hypothesis that disgust affects SOI psychology, which in turn influences sexual behavior; however, our results suggest these relationships are complex.

4.1. Sex differences in disgust and sociosexuality (H1)

Consistent with previous research (Al-Shawaf, Lewis, & Buss, 2015; Oaten et al., 2009; O'Shea et al., 2019; Tybur et al., 2009; Tybur, Bryan, Lieberman, Caldwell Hooper, & Merriman, 2011), women scored

Table 2
El Salv = El Salvador group; US Uni = US university group. Standardized *b* (SD), *$p < .05$, ** $p < .01$, *** $p < .001$. Model fit: RMSEA = 0.05, CFI = 0.97, TLI = 0.96, SRMR = 0.07.

	In-Person Samples		Online Samples				
				Four Countries Sample			
Parameter	US Uni	El Salv	Global	Brazil	India	Italy	US online
Sexual Disgust							
Indirect							
SOI attitude	−0.12 (0.02) ***	−0.05 (0.02) **	−0.16 (0.02) ***	−0.15 (0.02) ***	<0.01 (0.02)	−0.16 (0.02) ***	−0.16 (0.02) ***
SOI desire	−0.01 (0.01)	<0.01 (0.01)	−0.01 (0.01)	−0.07 (0.02) ***	−0.03 (0.02)	−0.01 (0.01)	−0.03 (0.02)
Direct	0.17 (0.03) ***	−0.35 (0.10) ***	0.23 (0.04) ***	0.21 (0.03) ***	0.19 (0.03) ***	0.08 (0.05)	0.21 (0.04) ***
Total Effect	0.04 (0.03)	0.41 (0.09) ***	0.05 (0.04)	−0.01 (0.04)	0.17 (0.04) ***	−0.09 (0.06)	0.03 (0.04)
Total Indirect Effect	−0.13 (0.02) ***	−0.05 (0.02) **	−0.18 (0.02) ***	−0.22 (0.03) ***	−0.03 (0.03)	−0.17 (0.02) ***	−0.18 (0.03) ***
Pathogen Disgust							
Indirect							
SOI attitude	0.02 (0.01) *	0.02 (0.01) *	0.07 (0.02) ***	0.02 (0.01) *	0.02 (0.01) *	0.02 (0.01) *	0.10 (0.02) ***
SOI desire	0.02 (0.01) *	<0.01 (0.01)	0.02 (0.01) *	0.02 (0.01) *	0.31 (0.05) ***	0.02 (0.01)	0.04 (0.02) *
Direct	−0.05 (0.03)	−0.06 (0.03)	−0.05 (0.03)	−0.05 (0.03)	−0.05 (0.03)	−0.06 (0.03)	−0.05 (0.03)
Total Effect	−0.01 (0.03)	−0.04 (0.03)	0.04 (0.03)	−0.01 (0.03)	0.28 (0.05) ***	−0.02 (0.03)	0.10 (0.04) **
Total Indirect Effect	0.04 (0.02) **	0.02 (0.01)	0.09 (0.02) ***	0.04 (0.02) **	0.33 (0.05) ***	0.04 (0.01) **	0.15 (0.03) ***

significantly higher on all domains of disgust across all the groups. The sex differences in both moral and pathogen disgust appeared modest and of equal size across all groups, whereas the difference in sexual disgust was modest and of equal size in all groups except El Salvador, in which it was large. In more conservative cultures like El Salvador, women's sociosexuality may be more influenced by cultural expectations of virginity and sexual fidelity (e.g., Dawson & Gifford, 2001; Manderson, Kelaher, Woelz-Stirling, Kaplan, & Greene, 2002), which may be reflected by very high scores on the sexual disgust subscale. Taken together, these findings provide evidence of striking universality for the mean differences in disgust between males and females.

Women also indicated a more restricted composite SOI, which is also consistent with past research (Al-Shawaf, Lewis, & Buss, 2015; Brase, Adair, & Monk, 2014; O'Shea et al., 2019; Penke & Asendorpf, 2008; Schmitt, 2005). Sex remained a significant predictor of composite SOI in our multiple regression models after controlling for all domains of disgust, age, and country of residence. This suggests that sex explains variation in SOI that is not accounted for by disgust. While these sex differences may in part stem from religious and patriarchal influences (Ussher et al., 2012), asymmetries in the consequences of sexual activity likely constitute an underappreciated, ultimate-level explanation. Although asymmetry in obligate parental investment is usually cited as the ultimate origin of sex differences in sexual behavior (Trivers, 1971), asymmetries in the deleterious effects of pathogens might also affect sex-specific sexual behavior. Not only are women more likely to contract an STI, but these infections can also have long-term consequences on reproductive success (Buss, 2012; Schryver & Meheus, 1990). In other words, STIs are likely more dangerous to women than men (Buss, 2012; Schryver & Meheus, 1990). Therefore, sex differences in disgust may be linked to the sex difference in sociosexual orientation, such that disgust may regulate the direct trade-off between infection risk and reproductive benefit in a context- and person-specific manner (Tybur & Lieberman, 2016; Lieberman & Patrick (2018)). Future research should aim to unpack the relative importance of infection risk as an ultimate explanation—complementary with parental investment asymmetry—for sex differences in mating strategies.

4.2. The relationship between disgust and sociosexuality (H2 and H3)

Previous studies on the relationship between disgust and SOI did not account for shared variance among domains of disgust; therefore, we used multiple regression to examine the unique variance in SOI explained by each domain of disgust (Billingsley et al., 2018). In these models, sexual disgust negatively predicted composite SOI across all four samples, replicating past research (Al-Shawaf, Lewis, & Buss, 2015; O'Shea et al., 2019; Sevi et al., 2018). Surprisingly, pathogen disgust *positively* predicted SOI attitude and desire across all samples. In other words, sexual and pathogen disgust both explained unique variance in SOI attitude—but in opposing directions. Moral disgust also positively predicted composite SOI in the four-countries online sample, which was our highest powered sample, as well as SOI desire across all samples. Together, these findings suggest that sexual and pathogen (and potentially moral) disgust may have opposing effects on composite sociosexuality, but that larger samples may be needed to detect these effects.

The detected relationship between pathogen disgust and SOI attitude and desire stands in contrast to our hypothesis. These findings are not well explained by the behavioral immune system theoretical framework (Schaller & Park, 2011) because participants with greater pathogen disgust are reporting increased desire for an activity that carries greater pathogen risk. This result, however, may potentially align with two other theoretical frameworks: 1) the "bet-hedging hypothesis" and 2) good genes models.

First, the bet-hedging hypothesis posits that individuals may increase their variety (i.e., amount) of sexual partners in pathogen-risky contexts (e.g., high perceived vulnerability to diseases and in pathogen-dense environments; Beaumont, Gallie, Kost, Ferguson, & Rainey, 2009; Simons, 2011; Yasui, 2001). This is a "risk-spreading" strategy (Hopper, 1999) and is proposed to increase variability in offspring immunity through multiple paternity, which should increase survival of at least some offspring by "hedging your bets" with multiple offspring varying in likelihood of survival. While this behavioral pattern has been documented in a variety of species (e.g., Beaumont et al., 2009; Hopper, 1999; Simons, 2011), Hill, Prokosch, and DelPriore (2015) also found support for this hypothesis in humans.

Hill et al. (2015) found that women with increased perceived vulnerability to disease reported a higher number of desired future partners in the future, compared to those who did not view themselves as vulnerable. Further, this effect was especially strong when the participants were exposed to a disease threat prime. If those with higher perceived vulnerability to disease have higher pathogen disgust, as past studies suggest (Duncan, Schaller, & Park, 2009; Santisi, Magnano, & Scuderi, 2021; Tybur et al., 2009), then the positive relationship between pathogen disgust and SOI found in our results may be explained through the lens of a reproductive pathogen-management strategy. That is, those who perceive themselves as more vulnerable desire more novel partners (i.e., a less restricted mating strategy) in order to diversify their offsprings' immunocompetence. Hill et al. (2015), however, found that only women seemed to increase desire for multiple partners under cues of pathogen stress. In contrast, in our study, we find that higher pathogen disgust predicts a less restricted sociosexual orientation in both males and females. Future studies should continue this line of inquiry by

analyzing this relationship within participants at two different time points or compare participants cross-sectionally in locations varying in pathogen ecologies.

A second possible theoretical framework is the "good genes" model. In environments with higher pathogen risk, women may benefit by pursuing the males with the highest apparent immunocompetence (Larmuseau et al., 2019; Little, DeBruine, & Jones, 2011; Little, Jones, Penton-Voak, Burt, & Perrett, 2002; Penton-Voak & Perrett, 2000; Zietsch, Westberg, Santtila, & Jern, 2015). That is, highly infectious environments necessitate greater deployment of a mixed-mating strategy. Lowering disgust sensitivity in higher pathogen environments may promote a mating strategy (i.e., a mixed reproductive strategy) where women can secure healthy genes from a higher genetic quality male and thus produce more resilient offspring with varied immunity, while maintaining quality investment from a male that may not have as "good" genes (e.g., Aitken, Lyons, & Jonason, 2013; Durante, Griskevicius, Simpson, Cantú, & Li, 2012; Little et al., 2011). Therefore, increased pathogen threat would promote less restricted sociosexuality among women in order to facilitate mating with higher quality, but less investing men while securing investment and resources from another man.

4.3. The pathway from disgust to sexual behavior (H4)

In addition, we improved upon the design of previous studies (Al-Shawaf, Lewis, & Buss, 2015; O'Shea et al., 2019) by conducting separate models for each domain of SOI. These results suggest that correlations between sexual disgust and composite SOI obscure the nature of the relationship between disgust and each facet of SOI. In other words, results showed that the psychological domains (i.e., attitude and desire) are largely driving the relationship between sexual disgust and composite SOI.

Across most samples, excluding the Indian subsample of the four-country online sample, mediation results support our hypothesis, such that sexual disgust was negatively related to SOI attitude, which in turn positively predicted SOI behavior. Further, pathogen disgust predicted SOI behavior indirectly via both SOI attitude and desire, suggesting that different facets of psychological sociosexuality connect different domains of disgust to sexual behavior. Ultimately, these results highlight that different domains of disgust have unique impacts on different aspects of sociosexual psychology, which both have a similar effect on sociosexual behavior.

4.4. Individual variation in disgust and SOI

In addition to sex, there is evidence of other individual-level traits influencing one's disgust sensitivity. For example, individuals with higher perceived vulnerability to diseases tend to report higher disgust sensitivity (Duncan et al., 2009; Santisi et al., 2021; Tybur et al., 2009, but see Hill et al., 2015 for opposing results). This aligns with the BIS; avoidance of sexual contact when infection prevalence or immune vulnerability are high may be particularly adaptive (Barber, 2008). Indeed, studies have found that those with higher perceived vulnerability to diseases and increased germ aversion demonstrate a tendency toward germ-averse behaviors and report a more restricted sociosexual orientation (Duncan et al., 2009; Moran et al., 2021);

In our own results, age was predictive of both SOI attitude and behavior across all groups, although in opposite directions. While we didn't have explicit hypothesis regarding the effect of age on SOI, these patterns do shed light on individual variation in SOI across the lifespan. Immune function declines with age, possibly leading to an increase in vulnerability to disease (Graham, Christian, & Kiecolt-Glaser, 2006; Yung, 2000). Further, conservatism tends to increase with age (Truett, 1993), and global studies have shown that SOI fluctuates in line with conservative views and religiosity (Schmitt, 2005). Overall, these results combined with the previous literature suggest that the BIS is facultative to maximize resource consumption and pathogen-protection for the individual. Future research should assess the relationship between disgust sensitivity and SOI in participants who vary in these individual factors; these results may illuminate how the relationship between pathogen avoidance and mating strategy fluctuates in order to promote the most successful strategy at any given time.

4.5. The bi-directional nature of disgust and behavior

Several studies have demonstrated that state-level sexual arousal may down-regulate disgust sensitivity (Borg & de Jong, 2012; Fleischman, Hamilton, Fessler, & Meston, 2015); that is, sexual arousal downregulates disgust to facilitate sexual contact. In contrast, more recent research on trait-level mating strategies (i.e., sociosexual restrictiveness), suggests a negative relationship when regressing disgust on sociosexuality (Gruijters et al., 2016; Moran et al., 2021; Murray et al., 2013). Studies have shown that experimental disgust-priming and reported germ aversion levels are linked to more restricted sociosexuality (Moran et al., 2021); thus, restricting sexual behavior, especially with unknown sexual partners, may be a pathogen-avoidant behavior. Together with the present results, these studies suggest that there may be a bi-directional relationship between disgust sensitivity and sociosexuality, such that certain emotional and physiological states (e.g., induced disgust, sexual arousal) may affect reported psychological states (e.g., disgust sensitivity, openness to casual sex).

In a similar manner, research on the relationship between hunger and disgust has presented differing results, also possibly linked to a similar type of bi-directional causality. Ainsworth and Maner (2014) found that increased short-term hunger induced by a short-term five-hour fast was linked to over-categorization of potentially pathogenic social stimuli; that is, those who were hungry were more likely to identify people as having pathogen-cue traits than those who weren't hungry. The authors hypothesized that the hunger state makes you more aware of pathogen risks in the environment. However, other studies have found no link between disgust and hunger (Perone et al., 2021) or a small positive correlation between disgust and hunger (Al-Shawaf & Lewis, 2013). Interestingly, even when no link was detected between hunger and disgust, hungry participants did report increased openness to new foods (i.e., decreased food neophobia) compared to sated participants (Perone et al., 2021), and food neophobia has been positively related to disgust (Al-Shawaf, Lewis, Alley, & Buss, 2015; Santisi et al., 2021). Thus, while disgust may not be explicitly linked to hunger, one's openness to new foods may fluctuate in line with hunger and resource availability.

4.6. The impact of SARS-CoV-2

Although not the focus of the present investigation, our four-country online sample was collected during April 2020, just after the pandemic was announced and many countries began lock-down and restricted socialization (Andersen, Rambaut, Lipkin, Holmes, & Garry, 2020). Previous research shows that disgust sensitivity may be heightened in times of pathogenic stress (Hlay et al., 2021; Skolnick & Dzokoto, 2013); however, our results do not reflect this trend. Instead, the pre-pandemic sample (i.e., the global online sample) reported higher pathogen disgust sensitivity and sociosexual behavior. While this pattern was not predicted, it is in line with our findings that there may be a positive relationship between pathogen disgust and sociosexuality. One possible explanation for this finding is that SARS-CoV-2 may not impact the BIS the way other diseases might (Ackerman, Tybur, & Blackwell, 2021). Ackerman et al. (2021) contend that the BIS may have evolved to react to more common infectious diseases and their cues, rather than pandemics. Lastly, this was a comparison between two separate, independent samples. Future research should assess this relationship using within-participant comparisons, which may yield different results or provide better insight into this pattern.

4.7. Cross-cultural research

The present research suggests overall trends across samples, as well as notable inter-population variation. In general, much of the disgust literature is based on university student participants (Al-Shawaf, Lewis, Ghossainy, & Buss, 2018; Al-Shawaf, Lewis, Alley, & Buss, 2015; Al-Shawaf, Lewis, & Buss, 2015; Al-Shawaf & Lewis, 2013; Batres & Perrett, 2020; Borg & de Jong, 2012; Clay, Terrizzi, & Shook, 2012; Fessler & Navarrete, 2004; Lieberman, Tybur, & Latner, 2012; Reid et al., 2012; Stevenson et al., 2012; Tybur et al., 2009, 2010), or online samples (Aarøe et al., 2016; Debruine, Jones, Tybur, Lieberman, & Griskevicius, 2010; Fessler, Eng, & Navarrete, 2005; O'Shea et al., 2019; Sevi et al., 2018), with some of the online samples limited to the US (Navarrete & Fessler, 2006; Tybur et al., 2009, 2015). Importantly, very few of these studies report the ethnicity, nationality, or geographic breakdown of the participants. To test the adaptive function of traits, researchers must strive to understand the origins of variation (Apicella, Norenzayan, & Henrich, 2020; Barrett, 2020; Gurven & Lieberman, 2020). For example, sociosexual desire was negatively predicted by moral disgust only in the El Salvador sample. It is possible that moral disgust has a stronger influence on sociosexuality in more religiously conservative countries, such as El Salvador. This is in line with the findings that social and religious conservatism may work to limit pathogen transmission from multiple sexual partners (Schaller & Murray, 2008, 2012; Stewart, Adams, & Senior, 2020; Tybur et al., 2015). Additionally, sex differences in SOI and sexual disgust were substantially larger in the El Salvador sample, suggesting that additional cultural and environmental factors may influence these measures.

Because there may be considerable variation in disgust and sociosexuality based on culture and environmental factors (Batres & Perrett, 2020; Clay et al., 2012; Fincher et al., 2008; Gruijters et al., 2016; Hlay et al., 2021; Schaller & Murray, 2008; Schmitt, 2005; Skolnick & Dzokoto, 2013), future research should aim to include diverse and underrepresented populations, as well as be more transparent about demographics to increase the replicability and generalizability of results. For instance, our results demonstrate that disgust predicts facets of the SOI similarly across countries; this suggests a generalizeable pattern regardless of differences in culture and environment within our samples. Future studies may also benefit from including individual differences variables as potential moderators, such as life history strategy (Frederick, Keil, Bassioni, & Khan, 2018; K. Hill, 2005; Reiches et al., 2009; Stearns, 1989), age (Bribiescas, 2001; Cox et al., 2010; Ellison et al., 2012; Pavelka & Fedigan, 1991), perceived vulnerability to diseases and individual health status (Murray et al., 2013; Schaller & Park, 2011), as well as environmental harshness and pathogen load (Batres & Perrett, 2020; Hill et al., 2015).

Future studies may also benefit from additional measurement approaches. While BIS theory suggests that pathogen disgust and sociosexuality should be linked evolutionarily—sexual behavior can be extremely costly if infectious (Schryver & Meheus, 1990)—the construction of the TDDS (Tybur et al., 2009) may obscure this relationship by excluding sexual pathogen cues from the pathogen disgust domain. Most of the pathogen domain questions in the TDDS ask about rotting food, insects, and rodents as vectors of pathogens, while the sexual domain questions focus on behaviors with no cues of pathogens (e.g., hearing two strangers have sex, watching a pornographic video). Thus, further study might examine pathogen avoidance directed at sexual behavior that could have been missed by the TDDS (e.g., Gruijters et al., 2016), and possibly explored through use of a different scale (e.g., the Sexual Disgust Inventory; Crosby, Durkee, Meston, & Buss, 2020) or an expansion of the TDDS, both of which should be validated cross-culturally.

5. Conclusion

The BIS/disgust framework suggests an adaptive pathway—an individual detects pathogen cues, which trigger a psychological response (i.e., disgust), which then facilitates pathogen-avoidance behaviors. In the present research, we tested the latter half of this system in four diverse samples. We found that higher sexual disgust and lower pathogen disgust were associated with more restricted composite SOI. These results suggest that other possible explanations for the relationship between disgust and sociosexuality, such as the bet-hedging hypothesis or good genes selection, may better explain certain results than the BIS. Our results also show that disgust predicts sociosexuality at the psychological level, which then influences sociosexual behavior. These findings suggest a much more complex relationship between disgust and sociosexuality than previously reported, and that using solely composite SOI scores may distract from more nuanced patterns within this relationship.

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Author contributions

JKH conceptualized hypotheses and study design, data collection, conducted analyses, and drafted the manuscript. GA aided in data collection and analyses, as well as editing the manuscript. CB collected data from El Salvador and gave feedback on the manuscript. KW helped with statistical analyses, and editing the manuscript. GR advised on and conducted statistical anaylses. GR, CP, and SA contributed funding and gave feedback on the manuscript. ZS gave feedback on the manuscript. CRH-S aided in study design, contributed funds, helped with data collection, analyses, and drafting and editing the manuscript. All authors gave final approval for publication and agree to be held accountable for the work performed therein.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

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