

**Sociosexual Attitudes Mediate the Relationship Between Behavioral Immune System  
Reactivity and Religiosity**

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**Word Count (Abstract):** 179

**Word Count (Main Text):** 7,468

Accepted for publication at *Evolutionary Behavioral Sciences*\*

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### Abstract

Religiosity can be costly from a fitness perspective, but it is a cross-cultural universal, suggesting that it must confer other adaptive advantages. Compelling evidence suggests that religiosity could function as an evolved defense against infectious disease, but the specific mechanisms involved are underdetermined. The present study examined the relationship between disgust sensitivity, a key aspect of behavioral immune system reactivity, and religiosity by testing three potential mediators: adherence to traditional practices, out-group avoidance, and a monogamous sexual strategy. A cross-national, online adult sample ( $N = 289$ ) completed measures of religiosity, disgust sensitivity, traditionalism, ethnocentrism, and sociosexual orientation. Mediation analyses showed that the positive relationship between pathogen disgust and religiosity was partially mediated by more restricted sociosexual attitudes (34%), supporting the sexual strategies model of religiosity. No evidence was found for traditionalism or ethnocentrism, contradicting the adherence to tradition and out-group avoidance models. These results suggest that religiosity may be partially motivated by a monogamous mating strategy to support reproductive goals by minimizing costly mating errors. Findings contribute to understanding of the behavioral immune system and motivational underpinnings of religiosity.

*Keywords: behavioral immune system (BIS), religiosity, disgust sensitivity, sexual strategies*

### Public Significance Statement

Previous research suggests that people who experience disgust more readily are also more religious. Our findings help to explain this relationship by showing that greater levels of disgust in religious people may be partially explained by a monogamous mating strategy rather than a general avoidance of out-groups or an affinity for tradition. These results help us to better understand individual differences in religiosity.

## **Introduction**

Religion is a cross-cultural universal, and religiosity often requires devout behavioral adherence and restriction of counter-normative behavior, resulting in opportunity costs as well as costly signals (e.g., regular participation in religious services; Fincher & Thornhill, 2012).

Religiosity can broadly be defined as positive cognitive, behavioral, and affective involvement in a religion. Perhaps owing to the heterogeneity of religiosity, many different perspectives have been put forward on its evolution (for an overview, see Boyer & Bergstrom, 2008). Discussion continues as to whether religiosity is best considered an adaptation (e.g., to facilitate cooperative behavior; Sosis & Alcorta, 2003) or a byproduct of other cognitive processes (e.g., such as a hypersensitive agency-detection mechanism; Boyer, 2003). Recent work argues that religiosity may function as an evolved defense against infectious diseases (Terrizzi, 2017), suggesting that religiosity, and particularly religious conservatism, can be explained by the behavioral immune system. Whereas disease avoidance accounts of social and political conservatism have received close attention (see, e.g., Inbar et al., 2009; Terrizzi et al., 2013; Tybur et al., 2010, 2015a, 2016), ambiguity exists regarding the specific psychological mechanisms involved in disease avoidance accounts of religiosity. Different accounts of why disease avoidance leads to religiosity produce psychological predictions to better understand the evolution of religiosity and its relationship with the behavioral immune system.

## **The Behavioral Immune System**

Behavior that functions to avoid infectious disease results from an integrated set of psychological mechanisms known as the behavioral immune system (BIS; Schaller, 2006).

According to this model, disease-relevant information at multiple levels automatically activates the emotions and cognitions of the BIS, resulting in avoidance behavior (Schaller & Park, 2011).

Converging lines of evidence support the hypothesis that disgust is the central emotion adapted for avoiding infectious disease (Curtis et al., 2011; Oaten et al., 2009; Tybur et al., 2013; Tybur & Lieberman, 2016). First, disgust is reliably elicited by stimuli with cues to the presence of pathogens but not similar control stimuli (e.g., the same man's face with and without red spots; Curtis et al., 2004). Second, it motivates avoidance behavior (e.g., Shook et al., 2019). Disgust sensitivity also seems to be calibrated to contextual factors that influence the likelihood of disease, such as self-reported health (Hlay et al., 2024) and regional variability in disease risk (Hlay et al., 2021; Skolnick & Dzokoto, 2013).

Disgust is often thought to have originally evolved closely with other taste adaptations to avoid ingestion of harmful substances (e.g., poisons) and pathogens (Rozin & Todd, 2015). Kelly (2011) argued that our disgust adaptations originate from the integration of two evolved systems, one for the rejection of harmful toxins and one for the avoidance of infectious disease. The ubiquity of pathogen risks in the environment means that the cognitive architecture of disgust is adapted to be quite sensitive to pathogen cues in any context they are likely to be present (Tybur & Lieberman, 2016). For example, social contact presents a serious disease threat to humans (Curtis et al., 2011; Mousa et al., 2021). For this reason, activation of the BIS (e.g., state disgust) and individual differences in BIS reactivity (e.g., trait disgust sensitivity) influence social behavior and moral attitudes, such as interpersonal interaction and cultural values (Białek et al., 2021; Schaller & Park, 2011; for a discussion of disgust within the wider set of moral emotions, see Schnall & Henderson, 2023). Moreover, the expanding role of disgust across time to different elicitors means that it now functions in distinct domains. Tybur et al. (2009) developed The Three Domains of Disgust scale, which indexes disgust sensitivity specific to elicitors from the pathogenic, sexual, and moral domains.

## **Disgust and Religiosity**

The behavioral immune system can provide a framework for understanding individual differences in religiosity. Indeed, the strongest association between disgust sensitivity and various indicators of social conservatism was observed to be religiosity by Terrizzi et al. (2010), and similar associations have been found in other samples (Stewart et al., 2020; Terrizzi et al., 2012; Tybur et al., 2015a). Tybur et al. (2010) found a null relationship between pathogen disgust and religiosity; however, their investigation was restricted to samples of college students and a single measure of religiosity. A recent meta-analytic review suggested that the association between disgust and religiosity is moderately large and robust (Yu et al., 2022). Importantly, this finding seems to be exclusive to forms of religious conservatism and fundamentalism: measures indicating forms of religiosity that reject traditional religious values or that indicate religious openness do not covary with disgust sensitivity (Terrizzi et al., 2012). In addition, this relationship is not accounted for by symbolic associations—e.g., due to rituals that emphasize symbolic cleansing—because moral disgust does not correlate with religiosity (Terrizzi et al., 2012; Terrizzi, 2017). Although the causal direction of these bivariate effects could be either direction, the null effect for moral disgust suggests that religiosity is not influencing disgust. Indeed, models of religiosity as disease avoidance assume that BIS reactivity leads to religiosity, rather than vice versa. Some indirect evidence for the directionality of this relationship is presented here, and a more thorough treatment of causality with regard to the present study can be found in the discussion.

The notion that religiosity is a functional feature of the BIS can also help to explain other observations about religiosity, which are indicative of the causal direction being from disgust sensitivity to religiosity. For example, common psychological accounts of religiosity—such as

terror management theory (Greenberg et al., 1986) attachment theory (Kirkpatrick, 2005) and compensatory control theory (Kay et al., 2010)—make weak predictions regarding the correspondence of religiosity and out-group prejudice, but Terrizzi et al. (2012) found that disgust sensitivity relates to prejudice towards out-groups (i.e., sexual minorities) partially through religious conservatism. There is also some causal evidence for the effect of disgust on religiosity. Experimental studies have demonstrated that olfactory induction of disgust increases self-reported belief in biblical truth (Adams et al., 2014) and pictorial induction of disgust increases religious scrupulosity (specifically fear of sin; Stewart et al., 2020). Some work shows that religious primes influences cleanliness (Preston & Ritter, 2012). Additionally, among religious participants induction of spiritual impurity results in increased disgust reactions (Ritter & Preston, 2011) and thought violations are rated as more disgusting by those that are more religious (Ritter et al., 2016). However, there seems to be a lack of experimental evidence for increased religiosity (e.g., through priming methods like Pasek et al., 2023) leading to pathogen or sexual disgust.

### **Religiosity as Disease Avoidance**

Evidence that disgust leads to religiosity has led some scholars to propose that religiosity may be an evolutionarily evoked disease avoidance strategy (Terrizzi et al., 2012; Terrizzi, 2017). This perspective differentiates three aspects of religiosity that may mitigate morbidity and mortality from infectious disease: adherence to traditional practices, out-group avoidance and conservative sexual strategies. Tybur et al. (2015a) tested these hypotheses as potential motivations for high disgust individuals to endorse more social conservatism. However, these three accounts require further testing as motivators of religiosity. The present study addressed

this gap by investigating whether the relationship between disgust and religiosity is motivated by one or more of adherence to tradition, out-group avoidance, or sexual strategies.

### **Three Accounts of The Relationship Between Disgust and Religiosity**

#### ***The Traditional Practices Account***

The traditional practices account holds that disgust motivates adherence to traditional practices, which in turn motivates socially conservative values (Tybur et al., 2015a, 2016). Terrizzi (2017) argues that cultural evolution has endowed religions with rules and rituals that have pathogen-neutralizing properties (e.g., washing before prayer or food preparation laws). In this way, religious individuals may gain a level of protection from pathogens. Tybur et al. (2016) tested this hypothesis as an explanation for the relationship between disgust sensitivity and endorsement of social conservatism, a broader ideological belief system that covaries with religiosity. They reasoned that if pathogen-avoidant individuals favor ideological positions that encourage adherence to traditional norms, then the association between disgust sensitivity and social conservatism should be strongest for affirmation of traditional values, which they demonstrated using a large cross-national sample. However, the measure of traditionalism used in that study—the traditionalism subscale of the Right Wing Authoritarianism Scale (RWA)—mostly contains items with explicit endorsement of religious content or condemnation of nontraditional sexual morality (Duckitt et al., 2010). Accordingly, the finding that disgust sensitivity relates most strongly to traditionalism can be taken as corroboration for the general relationship between disgust sensitivity and religiosity, but this association may be confounded with conservative sexual attitudes.

#### ***The Out-Group Avoidance Account***

Although adherence to traditions may combat encounters with parasites in one's immediate environment, one of the most important disease vectors for humans is other people (Mousa et al., 2021). The outgroup avoidance account holds that disgust sensitivity motivates out-group avoidance which then motivates religiosity (Terrizzi et al., 2012). The theoretical foundation for the BIS influence on out-group avoidance is widely accepted, but the argument for this function of religiosity in particular is made perhaps most strongly by Fincher and Thornhill (2012) and Terrizzi (2017). Host-parasite coevolution is locally specific, such that socially separated groups develop immunity to different parasites and harbor parasites to which other groups are vulnerable. Under these conditions, the BIS should motivate out-group avoidance, and individual differences in BIS reactivity (e.g., in disgust sensitivity) should be associated with motivations to avoid out groups (e.g., by increased prejudicial attitudes). One aspect of religiosity that has been difficult for scholars of religion to understand is its association with prejudice (Terrizzi et al., 2012). The out-group avoidance account of religiosity can explain the relationship between religiosity and prejudice as an avoidance strategy of diseases that pose a particularly strong immune threat.

Some evidence currently supports the out-group avoidance account. At a first glance, both religiosity and disgust sensitivity are associated with greater out-group prejudice (reviewed in Terrizzi et al., 2012). Next, although not at the individual-difference level, analyses of many traditional societies indicate that ecological parasite-stress is negatively associated with societal range (indicating the avoidance of other groups) and positively associated with religious diversity and richness, suggesting that the pressure of natural selection by disease may encourage both out-group avoidance and the formulation of religious groups to facilitate this (Fincher & Thornhill, 2008). At the individual level, Terrizzi et al. (2012) found support for a model in



which pathogen avoidance variables (e.g., disgust sensitivity) lead to prejudice towards sexual minorities through religiosity. They interpreted this as support for the out-group avoidance account, but prejudicial attitudes towards sexual minorities may be confounded by sexual content. These findings are therefore not able to differentiate between the out-group avoidance account and the sexual strategies account.

### ***The Sexual Strategies Account***

While out-groups may pose a particularly strong threat to immune functioning, another vector of disease transmission is sexual activity. The sexual strategies account holds that, to minimize costly mating errors, higher disgust sensitivity reflects a more monogamous mating strategy (Tybur et al., 2015a), which motivates religiosity to support these reproductive goals. Mating errors may include selection of a suboptimal partner or selection of a partner carrying a sexually transmitted infection (STI; Terrizzi et al., 2012; Terrizzi, 2017; Tybur et al., 2015), and a relatively monogamous mating strategy can help to mitigate these costs.

The sexual strategies model assumes that those scoring higher in pathogen disgust will be more likely to adopt a monogamous sexual strategy. Evidence on this point is mixed. An interplay between mating strategy and sexual disgust has been demonstrated and replicated in multiple samples (Al-Shawaf et al., 2015; O'Shea et al., 2019; Sevi et al., 2018), but results for pathogen disgust are more equivocal. For example, whereas Al-Shawaf et al. (2015) and O'Shea et al. (2019) found no relationship between pathogen disgust and sociosexuality, others have found that pathogen disgust is associated with more restricted sociosexual attitudes (Tybur et al., 2015a) and with less restricted sociosexual attitudes and desires (Hlay et al., 2022).

On the other hand, there is a plethora of suggestive evidence that sexual strategies may be the reason that people who are higher in disgust sensitivity tend to be more religious. Large

multi-national studies of the predictors of religiosity show that relatively monogamous mating strategies and conservative sexual attitudes are robust predictors (Weeden et al., 2008; Weeden & Kurzban, 2013), and bivariate correlations between disgust sensitivity and religiosity also tend to support that sexual disgust (compared to pathogen disgust and moral disgust; Tybur et al., 2009) is most strongly related to religiosity (Terrizzi et al., 2012; Tybur et al., 2015). In addition, parasite stress has been implicated in cross-cultural differences in mating strategies (i.e., restricted sociosexuality; Schaller & Murray, 2008). Indeed, while evoked culture accounts of parasite-stress on religiosity through disgust sensitivity have been questioned in the literature (Tybur et al., 2016), religiosity could plausibly be evoked by parasite stress and sociosexual attitudes if not disgust sensitivity.

Much of the work demonstrating that disgust sensitivity is associated with out-group prejudice uses sexual minorities as the target group (Aktas & Tosyali, 2024; Kiss et al., 2020, 2022; Terrizzi et al., 2012; Terrizzi et al., 2010; van Leeuwen et al., 2023). Although generally taken as evidence of out-group prejudice, sexual minorities undermine the successful enforcement of monogamous mating strategies in a community of potential partners, and so prejudice against sexual minorities can *also* be explained by the sexual strategies account.

Some suggestive causal evidence also exists. The notion that religiosity functions to support the successful enactment of a monogamous mating strategy is consistent with experiments showing that exposure to mating pools of attractive same-sex individuals—increased mating competition—results in higher self-reported religiosity (Li et al., 2010). More specific to disgust, Adams et al. (2014) find that olfactory induction of disgust results in higher self-reported endorsement of a variety of conservative views on sex as well as biblical truth.

Together, these findings suggest that the relationship between disgust and religiosity may be due to a monogamous mating strategy.

Other research has investigated the sexual strategies account more directly. In a multi-study test of the sexual strategies account for social conservatism more broadly, Tybur et al. (2015a) provide evidence for a model in which the relationship between pathogen disgust and religiosity is fully mediated by a monogamous mating strategy (replicated by Shook & Oosterhoff, 2020 for social conservatism; but also see Shook et al., 2015; Tybur et al., 2015b). In Study 2, the authors demonstrated that the relationship between parasite disgust sensitivity and religiosity is fully mediated by sexual disgust (as a proxy for a monogamous mating strategy). They did not, however, test their model with religiosity and the sociosexual orientation inventory (Penke & Asendorpf, 2008), which was designed to more specifically measure mating orientation than sexual disgust, which contains ancillary items.

In line with the prediction of the sexual strategies account that disgust sensitivity functions to reduce the costs of mating errors through a more monogamous strategy, there is evidence that people higher in disgust sensitivity find relatively unattractive faces even more unattractive than controls (Park et al., 2012). Whereas the benefits and costs of promiscuity are present for both sexes, higher female obligatory parental investment reduces their benefits and increases their costs on average for women (Trivers, 1972). Indeed, two prominent explanations for sex differences in disgust include the parental investment hypothesis that higher female disgust facilitates the enactment of a more “choosy” mating strategy and the STI hypothesis that higher female disgust facilitates avoidance of sexual disease transmission (Al-Shawaf et al., 2018), although tests of these and alternative hypotheses are still in progress (e.g., Stefanczyk et al., 2023; Stefanczyk & Pieniak, 2024; Stefanczyk & Zielińska, 2024). The sexual strategies

hypothesis of religiosity is a complement to the parental investment hypothesis and the STI hypothesis, yet regardless of the origin of sex differences in disgust, the sexual strategies hypothesis can explain why women tend to be more religious than men (Terrizzi et al., 2014). Indeed, Terrizzi et al. (2014) found that accounting for individual differences in disgust sensitivity attenuates sex differences in religiosity. Moreover, in line with the view of religiosity as a means of ensuring success of a monogamous mating strategy, a recent meta-analysis found that the relationship between disgust and religiosity is moderated by sex (Yu et al., 2022). If, as the parental investment and STI hypotheses suggest, females tend to experience greater disgust to avoid the costs of promiscuity, then disgust may be more strongly associated with religiosity among females in that it tends to facilitate a successful monogamous strategy.

### **The Present Study**

The present study tested three hypotheses, each of which proposes that the relationship between disgust sensitivity and religiosity is motivated by a given functional disease avoidance argument. For the traditional practices account (Hypothesis 1), the relationship between disgust sensitivity and religiosity is motivated by adherence to traditional practices. For the out-group avoidance account (Hypothesis 2), the relationship should be motivated by out-group avoidance. Last, the sexual strategies account (Hypothesis 3) holds that it should be motivated by a monogamous mating strategy.

## **Materials and Methods**

### **Data Accessibility Statement**

Data, code, and related materials are available at the Open Science Framework (OSF) repository at [https://osf.io/r7w9e/?view\\_only=b5cdae304a5c4ba28aa9482a386a5e58](https://osf.io/r7w9e/?view_only=b5cdae304a5c4ba28aa9482a386a5e58).

Preregistration information is available at

[https://osf.io/d2m9z/?view\\_only=b278d17c3fa64d1cb5af3c2bf8ffc56d](https://osf.io/d2m9z/?view_only=b278d17c3fa64d1cb5af3c2bf8ffc56d).

## Participants and Procedure

Ethical approval for this research was granted by the Trinity Western University Human Research Ethics Board (HREB; approval number 24U02), and all procedures complied with the APA Ethical Principles of Psychologists and Code of Conduct. Adult participants who were fluent in English were recruited through Prolific (<https://www.prolific.com>) and, after providing informed consent, were administered a survey consisting of a demographic questionnaire and psychological measures presented in random order. *A priori* power analyses with the *powerMediation* package (Qiu, 2021) using parameter estimates from previous studies (disgust  $B = .26$ , mediators  $B = .20-.22$ ; see OSF repository for full script) indicated that with 300 participants mediation effects could be detected with 80% power for each model. We recruited  $n = 298$  participants and  $n = 9$  were excluded for electing to halt their participation ( $n = 5$ ) or timing out ( $n = 4$ ). The final sample consisted of  $N = 289$  participants.

Prolific's balance sex tool ensured a similar number of both sexes (female  $n = 143$ , 49.5%), and the sample was composed of ethnically and nationally diverse adults (age  $M(SD) = 30.9(10.85)$ ). Of the 41 reported countries of nationality, most participants reported being from South Africa ( $n = 46$ , 15.9%), Mexico ( $n = 39$ , 13.5%) and Canada ( $n = 30$ , 10.4%). Full frequencies of participant nationalities ( $k = 41$ ) are available in *Table S4* in the supplementary materials. The most common ethnicity was White or Caucasian ( $n = 122$ , 42.2%), followed by Latinx or Hispanic ( $n = 62$ , 21.5%) and African ( $n = 52$ , 18.0%). Many participants reported no religious affiliation ( $n = 139$ , 48.1%) with the next most common affiliation being Christianity ( $n = 123$ , 42.6%). Of those who identified as Christian, most were Catholic ( $n = 68$ , 55.3%).

## Measures

### *Religiosity*

The Centrality of Religiosity Scale (CRS-5; Huber & Huber, 2012) was used to measure religiosity. The CRS-5 ( $\alpha = .92$ ) is a short questionnaire that assesses religiosity through five dimensions: intellect, ideology, public practice, private practice, and experience. Recent alterations to this scale generalize the language to make it suitable for cross-cultural samples, and it has demonstrated strong concurrent validity and internal reliability (Huber & Huber, 2012). We also asked participants to indicate how important religion was in their life by moving a slider between 0 and 100. This allowed for assessment of the concurrent validity of the CRS-5, as well as a robustness check with an alternative measure of religiosity.

### *Pathogen Disgust*

Disgust sensitivity was measured with the pathogen disgust subscale ( $\alpha = .77$ ) of the Three Domains of Disgust Scale (TDDS; Tybur et al., 2009). Participants completed all 3 subscales—pathogen, sexual, and moral disgust—but only pathogen disgust was analyzed because it allows for assessment of BIS reactivity without ancillary content. This instrument has shown convergent and divergent validity across a variety of concurrent measures (Olatunji et al., 2012; Tybur et al., 2009).<sup>1</sup>

### *Traditionalism*

An adapted form of the Conventionalism subscale of the Aggression-Submission-Conventionalism scale of authoritarianism (ASC-C; Dunwoody & Funke, 2016) was used to measure traditionalism. To ensure thorough construct representation, six items indicating

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<sup>1</sup> The TDDS is generally administered on a 0 (not disgusting at all) to 6 (extremely disgusting) scale, but due to a survey coding error it was administered here with 6, rather than 7, response options and the same anchors. Item scores therefore ranged from 0 to 5.

traditionalism were added to the scale. This final measure ( $\alpha = .83$ ; see Supplementary Materials for items) was used to test Hypothesis 1.

### ***Ethnocentrism***

Ethnocentrism was measured to provide a proxy for out-group avoidance motivations general enough to avoid two potential confounds: sex-stereotyped target groups and cultural specificity of in-group out-group distinctions. Thus, measuring ethnocentrism enabled us to (1) empirically differentiate results supporting the out-group avoidance account from results supporting the sexual strategies account and (2) achieve an estimate of out-group avoidance motivations from people across the world. We measured ethnocentrism using the In-Group Preference subscale of the short form of the Generalized Ethnocentrism Scale (SFGENE-7; Neto & Neto, 2022). The SFGENE-7 has shown adequate reliability despite fewer items than the full scale (GENE; Neuliep, 2002; Neuliep & McCroskey, 1997), as well as strong evidence for convergent validity with constructs like tolerance and multicultural ideology. In addition, it has been broken down via factor analysis into two distinct subscales, the first three items comprising the in-group preference scale and the last four items comprising the in-group superiority scale. The in-group preference scale shows stronger negative correlations with tolerance and multicultural identity than the in-group superiority scale. Thus, the in-group preference subscale was used to test the mediational hypothesis involving out-group avoidance. Although internal consistency for the preferences subscale was low ( $\alpha = .52$ ), removing item 1 markedly improved the internal reliability ( $\alpha = .80$ ), so Hypothesis 2 was tested both with and without item 1.

### ***Restricted Sociosexual Attitudes***

The Attitudes subscale ( $\alpha = .81$ ) of the Revised Sociosexual Orientation Inventory (SOI-R; Penke & Asendorpf, 2008) was used to operationalize a monogamous sexual strategy. The

SOI-R is a 9-item measure with three items each tailored towards behaviors, attitudes, and desires, which they differentiated based on exploratory and confirmatory factor analysis as well as convergent and divergent validation. In our preregistered analytic plan, we argue that because the sexual strategies account involves a monogamous mating *strategy*, *intention* is most relevant, and sociosexual desire or behavior may, or may not, correspond to sociosexual intentions, which is better captured with sociosexual attitudes. Some evidence for this perspective may exist, such as the finding that the attitudes component of the SOI-R relates more strongly to short-term mating interest among both males and females (Penke & Asendorpf, 2008). However, it may also be argued that a monogamous sexual strategy is better operationalized by sexual desire, which is a better predictor of behavior and is less influenced by sociocultural context (Penke & Asendorpf, 2008). The attitudes subscale of the SOI-R was used to operationalize a more monogamous mating strategy and formally test Hypothesis 3, but exploratory mediation analyses are also presented with each of the other components of the SOI-R (full, desire, and behavior) to better elucidate our results.

### **Data Analysis**

Data were analyzed in R (Ihaka & Gentleman, 1996) with the *mediation* package (Tingley et al., 2019). Specific plans to test for partial mediation and full mediation by breaking each hypothesis down into two statistical hypotheses, strong and weak versions, were preregistered. The regression procedures<sup>2</sup> of Baron and Kenny (1986) were employed, with two inferential criteria corresponding to both the strong and weak versions. For the strong versions, the relationship between pathogen disgust sensitivity and religiosity should be fully mediated by

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<sup>2</sup> If simple linear regression models failed parametric assumptions, inferences about statistical significance were made based on 95% bootstrapped confidence intervals (with 1,000 resamples) excluding zero.



traditionalism, ethnocentrism, or restricted sociosexual attitudes, and the “K” method outlined by Beribisky et al. (2020) was used to infer full mediation. That is, the proportion of variance explained by the indirect effect compared to the total effect must be 80% or higher to conclude full mediation. For the weak versions, the disgust and religiosity relationship should be partially mediated by these variables, and the 95% bootstrapped confidence interval for the indirect effect (based on 1,000 resamples) must not contain zero. All variables were standardized before analysis. In bivariate analyses, higher scores on the SOI-R attitudes subscale represent more unrestricted sociosexual attitudes, but the scale was reversed for mediation analyses so that higher scores represent more restricted sociosexual attitudes and, therefore, a more monogamous mating strategy.

## Results

### Bivariate Correlations

Bivariate correlations with means and standard deviations are shown in *Table 1* for each variable. As evidence for concurrent validity of the CRS-5 and religious importance, these measures were very highly correlated in this sample ( $r = .92, p < .01$ ). Pathogen disgust was moderately positively related to both religious importance ( $r = .22, p < .01$ ) and the CRS-5 ( $r = .24, p < .01$ ). Sexual disgust was more strongly related to both religious importance ( $r = .52, p < .01$ ) and the CRS-5 ( $r = .53, p < .01$ ). Supporting the auxiliary prediction of the sexual strategies hypothesis, pathogen disgust was negatively associated with unrestricted sociosexual attitudes ( $r = -.22, p < .01$ ). Bivariate correlations between each component of the TDDS and SOI-R are available in *Table S5* in the supplementary materials.

[TABLE 1]

### Mediation Analyses

In the preliminary simple linear regression model, pathogen disgust was positively related to religiosity ( $B = .24$ ,  $BCI = [.12, .35]$ ).

### ***Hypothesis 1: Adherence to Traditional Practices***

In simple linear regressions, pathogen disgust did not significantly predict traditionalism ( $B = .005$ ,  $t(287) = .089$ ,  $p = .929$ ), despite the observed association between traditionalism and religiosity ( $B = .31$ ,  $BCI = [.20, .42]$ ). This precluded the possibility of traditionalism mediating the relationship between pathogen disgust and religiosity, but full mediation results are displayed in *Table 2* and *Figure 1*. The bootstrapped confidence interval around the indirect effect for this model indicates that standardized estimates as small as  $ab = \pm .04$  can reasonably be rejected.

[FIGURE 1]

### ***Hypothesis 2: Out-Group Avoidance***

In simple linear regressions, pathogen disgust was not associated with ethnocentrism, whether using all items ( $B = .01$ ,  $t(287) = .244$ ,  $p = .807$ ) or removing item 1 ( $B = -.03$ ,  $BCI = [-.13, .11]$ ). In addition, ethnocentrism was not associated with religiosity both with ( $B = .06$ ,  $BCI = [-.04, .19]$ ) and without ( $B = .00$ ,  $BCI = [-.12, .12]$ ) item 1. This precluded the possibility that ethnocentrism could mediate the relationship between pathogen disgust and religiosity, but full mediation results are displayed in *Table 2* and *Figure 2*. The bootstrapped confidence interval around the indirect effect for this model indicates that standardized estimates as small as  $ab = \pm .01$  can reasonably be rejected.

[FIGURE 2]

### ***Hypothesis 3: Sexual Strategies***

In preliminary simple linear regressions for the sexual strategies model, pathogen disgust was positively associated with restricted sociosexual attitudes ( $B = .22$ ,  $BCI = [.10, .33]$ ). In

addition, more restricted sociosexual attitudes were associated with higher religiosity ( $B = .41$ ,  $BCI = [.30, .51]$ ). In the full mediation model, restricted sociosexual attitudes partially mediated the relationship between pathogen disgust and religiosity ( $ab = .08$ ,  $BCI = [.04, .13]$ ), with more restricted sociosexual attitudes accounting for 34% of the total effect. This finding supports the weak version of Hypothesis 3. Full mediation results are presented in *Table 2* and *Figure 3*.

[FIGURE 3]

[TABLE 2]

### Exploratory Analyses

Robustness checks were undertaken to ensure consistent results under alternative model specifications. First, to check for confounding by sex, sex was controlled for in all mediation models. Results remained unchanged, with only restricted sociosexual attitudes partially mediating the relationship between pathogen disgust and religiosity (see *Table S1* in Supplementary Materials). In this model, the indirect effect was 32% of the total effect. Next, religious importance was input as religiosity, rather than the CRS-5. Again, results remained unchanged for all mediation models, with restricted sociosexual attitudes mediating 36% of the total effect (see *Table S2* in Supplementary Materials). In addition, mediation models were estimated with only participants that explicitly identified as religious (excluding religious affiliation responses of “None,” “Agnostic,” “Atheist,” or “Anti-religious”;  $N = 141$ ). Results remained largely unchanged, except for in the sexual strategies mediation model (see *Table S3* in Supplementary Materials). While the indirect effect ( $ab = .07$ ,  $BCI = [.01, .14]$ ) was similar in magnitude, the total effect ( $c = .31$ ,  $BCI = [.05, .53]$ ) was larger in this model, resulting in a reduced proportion mediated (21%,  $BCI = [.05, .53]$ ). These estimates are tentative because they are exploratory and carry wider confidence intervals due to reduced power, but they may indicate

that the sexual strategies model can better explain why some people are religious and others are not, rather than differentiate devotion levels within religious populations.

In our preregistration, we planned to formally test the sexual strategies model with sociosexual attitudes as the mediator, but a monogamous mating strategy may be better operationalized by sociosexual desire. To assess whether results of the sexual strategies model would hold with alternative operationalizations, we reanalyzed the mediation model for Hypothesis 3 with each other component of the SOI-R (composite, desire, and behavior; all reverse coded such that higher scores indicate a more monogamous strategy). Like sociosexual attitudes, composite sociosexuality partial mediated the relationship between pathogen disgust and religiosity, but the proportion mediated was substantially lower (16%,  $BCI = [.04, .40]$ ). Neither sociosexual desire nor sociosexual behavior significantly mediated the relationship between pathogen disgust and religiosity, indicating that the entire mediation effect for composite sociosexuality was due to the sociosexual attitudes component. Full results for these analyses are presented in *Table S6* in the supplementary materials.

### Discussion

The present study tested three mediation scenarios representing different accounts (reviewed in Terrizzi, 2017) of the relationship between behavioral immune system reactivity and religiosity. Approximately one-third of the positive association between pathogen disgust and religiosity was mediated by more restricted sociosexual attitudes, aligning with preregistered predictions from Hypothesis 3. However, this relationship was not mediated by sociosexual desire, another plausible prediction from the sexual strategies model. We found no evidence that the relationship between pathogen disgust and religiosity was mediated by traditionalism, as predicted by the adherence to traditional practices account, or ethnocentrism, as predicted by out-

group avoidance account. Thus, the present findings provide some support for a disease avoidance model of religiosity in which people higher in pathogen disgust tend to be more religious due to a more monogamous mating strategy, and these findings reject disease avoidance models of religiosity that emphasize adherence to traditional practices (e.g., Tybur et al., 2016) or avoidance of out-groups (Fincher & Thornhill, 2012; Terrizzi et al., 2012). These results broadly align with those of Tybur et al. (2015), which tested the same theoretical models for social conservatism.

### **Disgust and Traditionalism**

Previous work has demonstrated a positive relationship between pathogen disgust and traditionalism (e.g., Tybur et al., 2016), a necessary prediction from the adherence to tradition account. We found no such association. One possible explanation is that prior work has employed measures that are confounded with sexual or religious content. Traditionalism is often measured using the Right Wing Authoritarianism (RWA) scale (Duckitt et al., 2010), which has explicitly religious and sexual items. Dunwoody and Funke (2016) addressed these limitations of the RWA scale by developing the ASC scale, which omits such items. This scale removes tautological problems when predicting religiosity, while retaining similar psychometric properties as the RWA scale. In particular, the subscale of conventionalism from the ASC scale mirrors the traditionalism subscale from the RWA measure but retains a positive relationship with religiosity (Dunwoody & Funke, 2016). The present results show that with an adapted version of this measure, there is no association between pathogen disgust and traditionalism. Although holding traditional religious and sexual values is surely a legitimate indicator of traditionalism, the null result here suggests that the relationship between disgust sensitivity and traditionalism may be contingent on traditional sexual and religious values, not traditionalism as

such. These findings can be explained more simply by the sexual strategies account than the traditional practices account.

### **Disgust and Out-Group Attitudes**

Results also contrast with previous work suggesting that religion may function to facilitate out-group avoidance. The primary evidence for the out-group avoidance account has employed sexual minorities as the target group (Terrizzi et al., 2012; Terrizzi, 2017)—but sexual minorities may undermine the enforcement of monogamous mating strategies in a community of potential partners (as argued by Tybur et al., 2015a) and transgress traditional sexual taboos. In this way, higher prejudice against sexual minorities among religious people can also be explained by the sexual strategies account. By employing a general measure of ethnocentrism (Neto & Neto, 2022)—and more specifically in-group preference—the confound of prejudicial sexual attitudes was avoided in the present analysis, showing that ethnocentrism is unrelated to religiosity or pathogen disgust. The inclusion of a measure of ethnocentrism enabled us to measure out-group avoidance motivation without being restricted by the in- and out-group distinctions of one culture—fitting for our sample which was drawn from across the world. Given the SFGENE-7's relationships with tolerance and multicultural identity, we considered ethnocentrism to be the best culture-free proxy of out-group avoidance motivations. However, these findings suggest that culture-specific measures of out-group avoidance motivations (e.g., using non-sexual, local out-group targets when sampling attitudes or behavioral intentions) will show a null relationship between disgust sensitivity and out-group avoidance motivations, and we encourage future research to confirm these predictions.

### **Disgust and Sexual Strategies**

Our preregistered finding that sociosexual attitudes partially mediate the relationship between pathogen disgust and religiosity supports the sexual strategies account. In this case, high disgust sensitivity is a part of a sexual strategy to minimize costly mating errors—such as suboptimal partner choice or transmission of STIs—by encouraging monogamy. This monogamous mating strategy could then motivate religiosity to support these reproductive goals. Religiosity may help to minimize mating errors by encouraging religious values of chastity before marital commitment, fidelity, and other restrictive sexual norms, either in a religious individual or a pool of potential partners in a religious community. This is to say that there are several ways in which religiosity can facilitate the successful enactment of a monogamous mating strategy, from mate selection to retention.

### ***Causation***

While the results of the mediation model are consistent with a causal model in which pathogen disgust leads to religiosity through a more monogamous mating strategy, the design used herein does not allow for explicit tests of causality and thus we cannot rule out alternative causal pathways. It is possible that, rather than disgust sensitivity leading to religiosity, religiosity may cause a more monogamous mating strategy and higher disgust sensitivity. The evidence for and against the causal sexual strategies model therefore deserve a more thorough treatment.

The analyses conducted in the present study assume—but do not demonstrate—a causal path leading from pathogen disgust to a monogamous strategy to religiosity. That said, this assumption may be justified based on extant evidence. As reviewed above, if greater religiosity were to cause greater disgust sensitivity, a positive relationship between religiosity and moral disgust would be predicted, which is *not the case* (Terrizzi et al., 2012; Terrizzi, 2017). There is

also experimental evidence that induction of disgust increases conservative sexual attitudes as well as certain aspects of religiosity (Adams et al., 2014; Stewart et al., 2020), demonstrating the possibility of a causal pathway from pathogen disgust to religiosity. In contrast, there is a dearth of experimental support for the specific path from religiosity to pathogen disgust, with existing evidence being largely tangential. For example, primes for religion have been shown to increase cleanliness (Preston & Ritter, 2012), and challenges to existing religious beliefs seem to increase moral disgust (Ritter et al., 2016) and disgust ratings of a drink (Ritter & Preston, 2011), but this work does not demonstrate that increased religiosity leads to increased pathogen disgust. Finally, theoretical plausibility must be addressed, because it is unclear from either a functionalist or adaptationist perspective how upregulation of pathogen disgust serves any purpose for religiosity. Each of these pieces of evidence suggest that rather than religiosity influencing disgust sensitivity through sexual strategies, disgust sensitivity influences religiosity through this mechanism.

Exploratory analyses may contradict some of the causal implications of the sexual strategies model, however. In the present study, the entire mediation effect between pathogen disgust and religiosity was driven by sociosexual attitudes, not by sociosexual desire or behavior. Although the preregistered model specified use of sociosexual attitudes, a strong case can be made that sociosexual desire better operationalizes a monogamous mating strategy. Sociosexual desire shows patterns of variability with relationship status (e.g., lower with a long-term partner and higher after relationship dissolution), which may imply that it is the psychological parameter that underlies differences in mating strategy (Penke & Asendorpf, 2008). Indeed, in developing the SOI-R, Penke and Asendorpf (2008) argued that the attitudes component is a measure of how



one presents themselves based on their cultural socialization. They noted that they would expect sociosexual attitudes to be influenced by one's religion rather than vice versa.

Penke and Asendorpf (2008) further demonstrated that whereas sociosexual desire predicted more flirtation and sexual behavior, sociosexual attitudes did not, suggesting that sociosexual attitudes reflect impression management rather than mating ambitions. That pathogen disgust and religiosity were mediated by sociosexual attitudes but not desire in the present study may suggest that sociosexual attitudes were influenced by religiosity rather than by pathogen disgust. This distinction is especially relevant because previous work testing the sexual strategies model for socially conservative values more broadly did not operationalize mating strategy using the desire subscale of the SOI-R (Tybur et al., 2015a). Our results call into question whether the sexual strategies model holds up to tests using a more tailored measure of mating strategy, suggesting that future work testing the sexual strategies model should exercise caution in how they operationalize this variable.

Careful future experimental study can help to clarify results here. The sexual strategies model can be probed by testing whether induced disgust in response to pathogen cues leads to religiosity through a more monogamous mating orientation, and additional experiments testing whether primes of religiosity (e.g., as in Pasek et al., 2023) influence disgust sensitivity through mating orientation can help to rule out reverse causation. Measures should include participant assessments of experienced disgust intensity, given that recent work suggests that it is disgust's construal (rather than simply the presence of disgust elicitors) that drives changes in moral judgements (Bialek et al., 2021). Multiple measures of mating strategy should be used to clarify the limits of the causal model; if pathogen disgust increases religiosity due to a more monogamous sexual strategy, our findings suggest that it does so specifically by making

evaluative dispositions towards having uncommitted sex more negative, not through downregulating uncommitted sexual desire. This distinction is crucial for understanding the validity and limits of the sexual strategies model.

A similar alternative view of the data presented here is that those lower in disgust sensitivity tend to have a less monogamous mating strategy. Seen this way, rather than a more monogamous mating strategy motivating religiosity, a more promiscuous mating strategy may motivate apostasy or discourage joining a religious community. This is plausible; variability in religiosity may partially reflect individuals for whom their sexual goals are typically considered counter normative by their community's religion and therefore pushed toward lower religiosity. More detailed elucidation of the sexual strategies of religious and non-religious individuals can help to illuminate these nuances.

Additionally, the results of this study could be interpreted as representing a mediation effect of disgust sensitivity and social conservatism by attitudes towards physical intimacy in social interactions more broadly. Such a model is consistent with a mediation effect by sociosexual attitudes but not sociosexual desire or behavior. This possibility has not been tested in the literature. Physical intimacy in social interactions will positively covary with pathogen transmissibility, ranging from social interaction where parasites cannot be transmitted (e.g., by phone; probability of transmission equals zero) to social interactions where parasites are almost surely transmitted (e.g., sexual intercourse; where the probability of transmission can be quite high; Hooper et al., 1978). Sexual strategies may mediate disgust sensitivity and social conservatism due to its relationship with attitudes towards highly physically intimate social interactions. In addition, here we are interested in religiosity, but the path from BIS reactivity through attitudes towards highly physically intimate social interactions may lead to social

conservatism more broadly, as articulated by Tybur et al. (2015a). The model tested in the present study and this more general model are not mutually exclusive. Rather, our model may be interpreted as a special case of this more general model, in which we tested subcomponents of the general model most relevant to religiosity.

Physical intimacy in social interactions should be directly related to the probability of transmitting infectious disease in general, and behaviors representing large increases in physical intimacy should represent large increases in the probability of transmitting infectious disease. To illustrate, even the difference in physical intimacy between giving a fist bump and shaking hands increases the probability of transmitting infectious disease (Mela & Whitworth, 2014), but when the physical intimacy involves exchange of bodily fluids, as with sexual acts, there will be a more substantial increase in the probability of exchanging infectious disease (see, e.g., Hooper et al., 1978; Platt et al., 1983). As such, BIS reactivity may relate to attitudes towards social interactions with a physical intimacy that crosses a critical threshold of disease transmissibility. Future research should determine whether the critical variable is sexual strategies or whether it is attitudes towards physically intimate interactions by measuring attitudes towards non-sexual but physically intimate social interactions (e.g., the tradition of becoming “blood-brothers” with cooperation partners; Gibbs, 1962).

### **Limitations**

Although these findings provide evidence in favor of the sexual strategies account and against the adherence to tradition and out-group avoidance account, assessment of the current work must also consider methodological limitations. First, measurement of constructs relied on self-report instruments, which can be unreliable, particularly when used to index sexual behavior (Chan, 2009; Kelly et al., 2013). In addition, the present study used an online convenience

sample, requiring added caution in interpreting results (although Prolific samples seem to yield high data quality; Peer et al., 2022). Volunteer participants were drawn from 41 countries and many cultural groups. If the mean values of both disgust sensitivity and religiosity are high within one particular country or culture, it is possible that this group-level peculiarity could have inflated the estimate of the individual-level relationship. Although our estimate aligns with estimates of the relationship between disgust sensitivity and religiosity in previous literature, future research should confirm these findings using data for which the disgust-religiosity link could not be spurious (e.g., only drawing participants from one cultural group or controlling for group-level variance in analyses). As well, although the sample provided plenty of variability in reported levels of religiosity, most religious participants identified as Christian. Generalizability of these results to religiosity *per se* is limited with this data, considering other religions do not necessarily encourage monogamy as strongly as Christianity (Hernandez et al., 2014). The sexual strategies model requires the enforcement of religious sexual norms that facilitate the successful enactment of a monogamous sexual strategy. Future research adequately representing a more diverse set of religious affiliations should test the auxiliary hypothesis that the culturally evolved sexual norms of different religious groups moderate the relationship between a more monogamous mating strategy and religiosity. Last, size of the study sample fell slightly short of the  $N = 300$  sampling target ( $N = 289$ ) given our power analyses, owing to budgetary constraints. The bootstrapped confidence intervals for mediation models suggest that most small effect sizes can be rejected in the null models; however, future investigations should aim for greater statistical power to yield more precise estimates.

## Conclusion

The relationship between BIS reactivity (i.e., disgust sensitivity) and religiosity has been well-established in the literature, and evidence such as this has prompted suggestions that religiosity can partially be considered an evolutionarily evoked disease avoidance strategy (Terrizzi, 2017). However, multiple mechanism for how religiosity facilitates disease avoidance—the adherence to tradition, out-group avoidance, and sexual strategies accounts—have not been sufficiently differentiated. Here, psychological predictions based on these mechanisms were tested. Findings support the sexual strategies account, where BIS reactivity contributes to religiosity partially through a more monogamous mating strategy. These findings enhance understanding of the BIS, as well as motivational underpinnings of religiosity.

**Disclosure Statement**

The authors report there are no competing interests to declare.

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## Tables

**Table 1**

*Descriptives and Bivariate Correlations of Key Variables for Mediation Models*

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7
1. Religious Importance	30.70	35.63							
2. CRS-5	2.59	1.26	.92** [.89, .93]						
3. Pathogen Disgust	21.26	6.35	.22** [.11, .33]	.24** [.13, .35]					
4. Sexual Disgust	15.54	7.76	.52** [.43, .60]	.53** [.44, .60]	.47** [.37, .55]				
5. Sociosexual Attitudes	5.16	2.40	-.39** [-.48, -.28]	-.41** [-.50, -.31]	-.22** [-.33, -.11]	-.59** [-.66, -.51]			
6. In-Group Preferences	6.81	2.03	.07 [-.04, .19]	.07 [-.05, .18]	.01 [-.10, .13]	.07 [-.04, .19]	-.15** [-.26, -.04]		
7. In-Group Preferences (2)	3.57	1.71	.02 [-.10, .13]	.00 [-.12, .12]	-.03 [-.14, .09]	.04 [-.08, .15]	-.11 [-.22, .01]	.88** [.85, .91]	
8. Traditionalism	35.55	10.30	.33** [.23, .43]	.31** [.21, .41]	.01 [-.11, .12]	.13* [.02, .24]	-.15* [-.26, -.04]	.08 [-.03, .20]	.03 [-.09, .14]

*Note.* In-Group Preferences (2) refers to the in-group preferences subscale of the SFGENE-7 without item 1. Values in square brackets indicate the 95% confidence interval for each correlation. \* $p < .05$ . \*\* $p < .01$ .

**Table 2***Mediation Model Parameter Estimates*

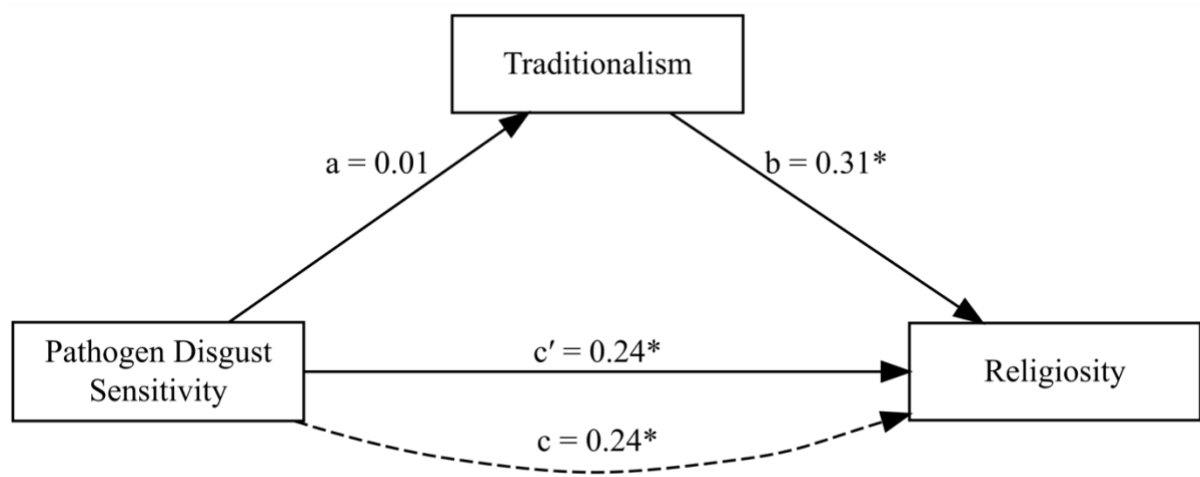
Mediator Model	Parameter	Estimate	Bootstrap Confidence Interval		<i>p</i>
			Lower	Upper	
Adherence to Traditional Practices	<i>ab</i>	.00	-.04	.04	.958
	<i>c'</i>	<b>.24</b>	<b>.13</b>	<b>.35</b>	<b>.000</b>
	<i>c</i>	<b>.24</b>	<b>.13</b>	<b>.36</b>	<b>.000</b>
	<i>Prop. Mediated</i>	.01	-.18	.18	.958
Out-Group Avoidance	<i>ab</i>	.00	-.01	.01	.812
	<i>c'</i>	<b>.24</b>	<b>.13</b>	<b>.36</b>	<b>.000</b>
	<i>c</i>	<b>.24</b>	<b>.13</b>	<b>.36</b>	<b>.000</b>
	<i>Prop. Mediated</i>	.00	-.04	.06	.812
Sexual Strategies	<i>ab</i>	<b>.08</b>	<b>.04</b>	<b>.13</b>	<b>.000</b>
	<i>c'</i>	<b>.16</b>	<b>.06</b>	<b>.27</b>	<b>.002</b>
	<i>c</i>	<b>.24</b>	<b>.13</b>	<b>.36</b>	<b>.000</b>
	<i>Prop. Mediated</i>	<b>.34</b>	<b>.16</b>	<b>.63</b>	<b>.000</b>

*Note.* *Prop. Mediated* refers to the proportion of the total effect accounted for by the mediator (i.e.,  $ab/c$ ). Lower and upper represent the lower bound and upper bound for the bootstrapped 95% confidence interval with 1,000 resamples, and *p* represents the p-value of the estimate based on the confidence intervals. Bold denotes  $p < .05$ .

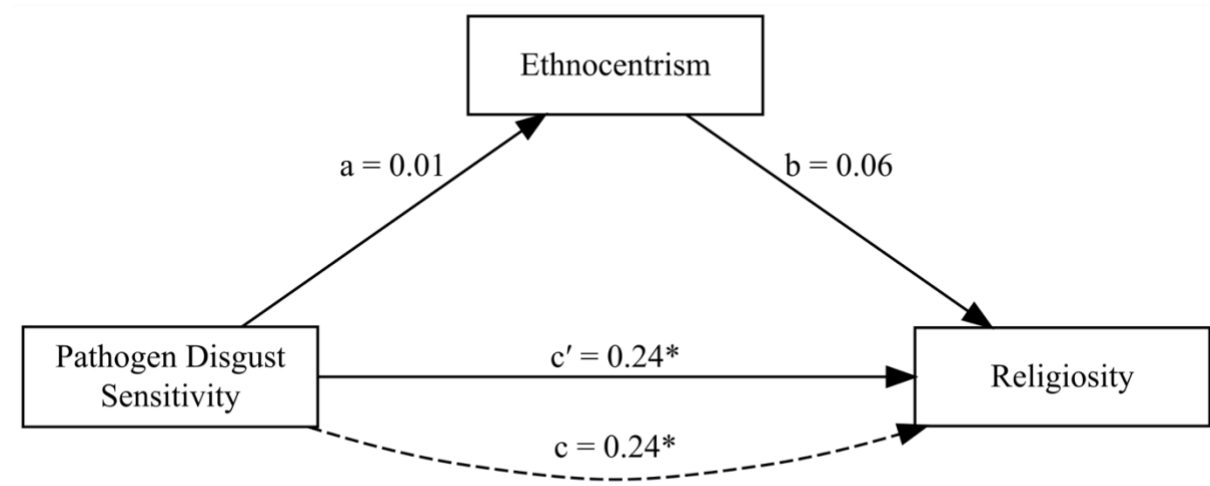
## Figures

**Figure 1**

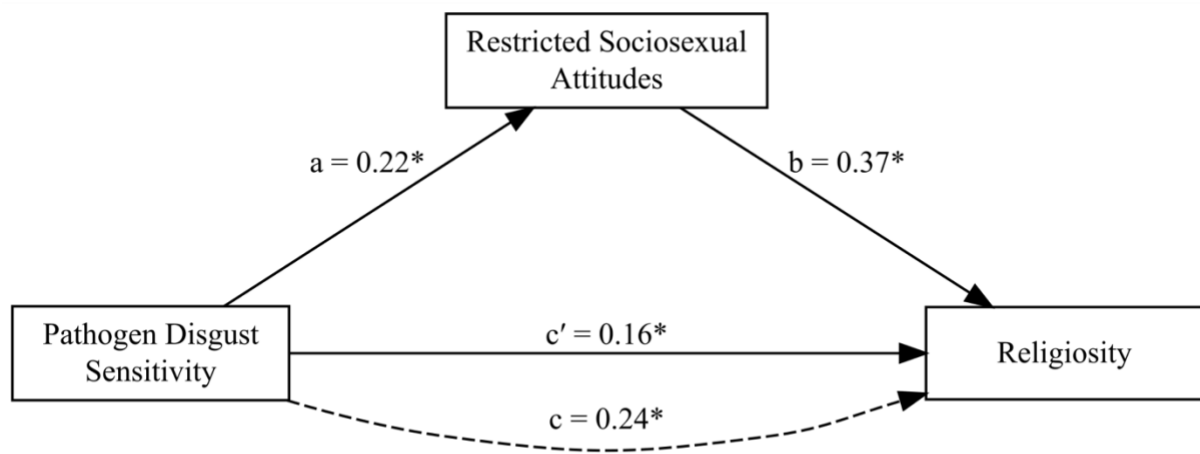
*Traditional Practices Mediation Model Path Estimates*



*Note.* \* denotes  $p < .05$ .

**Figure 2***Out-group Avoidance Mediation Model Path Estimates*

*Note.* \* denotes  $p < .05$ .

**Figure 3***Sexual Strategies Mediation Model Path Estimates*

*Note.* \* denotes  $p < .05$ .