Evolution and Human Behavior 36 (2015) 498–504

Contents lists available at ScienceDirect

Evolution and Human Behavior

journal homepage: www.ehbonline.org

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In defense of pathogen disgust and disease avoidance: a response to Tybur et al. (2015)

The behavioral immune system (BIS) is a set of psychological mechanisms (e.g., disgust sensitivity) that evolved to serve a disease-avoidance function (Schaller, 2006). As other individuals are a primary source of disease transmission, the BIS plays a role in the formation of social attitudes and behavior. Accumulating evidence indicates that the BIS is associated with varying forms of social conservatism, such as collectivism (e.g., Clay, Terrizzi, & Shook, 2012), right-wing authoritarianism (e.g., Hodson & Costello, 2007), religious fundamentalism (e.g., Terrizzi, Shook, & Ventis, 2012), social dominance orientation (e.g., Tybur, Merriman, Caldwell Hooper, McDonald, & Naverrete, 2010), and political conservatism (e.g., Inbar, Pizarro, & Bloom, 2009; Terrizzi, Shook, & Ventis, 2010). A recent meta-analysis indicated a moderate effect size for this relation (Terrizzi, Shook, & McDaniel, 2013). Theoretically, the BIS encourages individuals to endorse more socially conservative beliefs characterized by strict adherence to social norms, in-group cohesion, and out-group avoidance as a means of promoting disease avoidance (Terrizzi et al., 2013; Thornhill & Fincher, 2014).

Recently, Tybur, Inbar, Güler, and Molho (2015) have argued that this disease-avoidance explanation is inaccurate and proposed that the BIS is only indirectly associated with conservatism through sexual strategies. That is, individuals who are higher in pathogen avoidance tend to endorse more monogamous rather than promiscuous sexual strategies as a means of reducing pathogen transmission through sexual intercourse. These varying sexual strategies then influence beliefs, such that individuals who endorse more monogamous strategies are encouraged to adopt more socially conservative beliefs in order to reinforce their reproductive strategy. Across three studies, Tybur et al. demonstrate that indicators of the BIS (i.e., pathogen disgust, disgust sensitivity, and perceived vulnerability to disease) are only associated with conservative ideology (e.g., economic and social conservatism, religiosity) through sexual disgust and sexual strategies.

We have major theoretical and methodological concerns with the way Tybur and colleagues formulated and provided evidence to support their argument that bring into question the validity of their proposed model. In this paper, we outline the main theoretical, methodological, and data analytic problems with Tybur and colleagues' paper. We also present empirical evidence that refutes the proposed model and demonstrates a direct link between the BIS and social conservatism, controlling for sexual strategies.

1. Theoretical problems

Person-to-person contact is a significant route of infectious disease. However, disease transmission does not just occur through sexual intercourse. Pathogens may be transmitted through air, non-sexual contact with others, and exposure to bodily fluids. Thus, the BIS should encourage individuals to generally avoid others who could potentially harbor an infectious disease and adopt conservative social strategies, not just sexual strategies. Although monogamous sexual strategies as compared to promiscuous sexual strategies limit sexual contact with others and potential exposure to sexually transmitted diseases, sexual strategies do not address the other means by which diseases are transmitted.

As outgroup members were geographically separated in our ancestral past, they would have been exposed to different infectious diseases (i.e., pathogens endemic to their native land). Consequently, outgroup members are likely to have represented a significant disease threat. Thus, the BIS should encourage individuals to avoid outgroup members more than ingroup members (Schaller & Duncan, 2007). Indeed, numerous studies have demonstrated that those with a stronger BIS are more prejudiced toward outgroups (Faulkner, Schaller, Park, & Duncan, 2004; Inbar, Pizarro, Knobe, & Bloom, 2009; Park, Schaller, & Crandall, 2006; Terrizzi et al., 2010). Additionally, activating the BIS (i.e., priming disease threat) increases prejudice (Faulkner et al., 2004; Navarrete & Fessler, 2006). Socially conservative value systems may act as disease-avoidance strategies by promoting outgroup avoidance (see Terrizzi et al., 2013, for a review). In fact, inducing disgust increases prejudice toward sexual minorities for social conservatives, but not social liberals, supporting the disease-avoidance function of social conservatism (Terrizzi et al., 2010). Furthermore, social conservatism mediates the relation between the BIS and prejudice (Hodson & Costello, 2007; Terrizzi et al., 2012). Thus, the BIS may encourage the development of socially conservative values, which promote negative attitudes toward and avoidance of outgroup members.

It is unclear how the sexual strategies perspective would account for these findings. Tybur et al. (2015) do not address this growing body of literature or attempt to explain the empirical findings regarding prejudice within their theoretical framework. Perhaps outgroup members are potential sexual competitors and should be avoided. However, this fails to explain why priming disease threat increases prejudice. If the relation is simply about avoiding maladaptive sexual strategies, there is no explanation for the role of disgust and pathogen avoidance. A more parsimonious explanation is that contact with potentially contaminated outgroup members, whether through sexual intercourse or other forms of person-to-person contact, was historically an adaptive challenge which prompted outgroup avoidance via social conservatism.

Evidence also suggests that regional differences in parasite stress (e.g., years lost to infectious disease) are correlated with adherence to socially conservative values (Fincher & Thornhill, 2012; Fincher, Thornhill, Murray, & Schaller, 2008). These data can most easily be explained from a disease-avoidance perspective, rather than a sexual strategies perspective. Although parasite stress has implications for reproductive success, there are more general survival concerns. To argue that the adoption of socially conservative belief systems stems solely from sexual strategies is limited and does not account for the adaptive problems posed by disease prevalence.

Another issue with the sexual strategies perspective is that it fails to adequately account for sex differences. According to Tybur and colleagues, both males and females have reason to prefer monogamous relationships (e.g., males to avoid cuckoldry, females to ensure

Table 1
Comparison of fit statistics in replications of the models reported by Tybur et al. (2015) with and without covariance between measures of conservatism.

Study/Model	Covariance allowed?	*df*	X^2	*p*	ΔX^2/df	*CFI*	*RMSEA*
Study 1	Yes	3	1.83	.61		1.00	0.00
	No	6	1290.50	<.001	429.56	0.29	0.51
Study 2–TDD-P	Yes	7	11.40	.12		1.00	0.05
	No	28	1070.92	<.001	50.45	0.49	0.40
Study 2–DS-R	Yes	7	8.76	.27		1.00	0.03
	No	28	1068.28	<.001	50.45	0.50	0.40
Study 3–TDDS-P/TDDS-S	Yes	3	1.73	.63		1.00	0.00
	No	6	479.71	<.001	159.33	0.18	0.56
Study 3–TDDS-P/SOI	Yes	3	2.04	.56		1.00	0.00
	No	6	490.86	<.001	162.94	0.03	0.57
Study 3–GA/TDD-S	Yes	3	0.94	.82		1.00	0.00
	No	6	478.93	<.001	159.33	0.12	0.56
Study 3–GA/SOI	Yes	3	2.24	.53		1.00	0.00
	No	6	491.06	<.001	162.94	0.03	0.57

Note. TDDS-P = Three Domain Disgust Scale – Pathogen subscale; TDDS-S = Three Domain Disgust Scale – Sexual subscale; GA = Germ Aversion; SOI = Sociosexual Orientation Inventory. All models were constructed using the variance/covariance matrices provided by Tybur et al. (2015).

male parental investment). Thus, both sexes should be equally likely to subscribe to socially conservative strategies. This explanation, however, is not supported by well-documented sex differences in disgust sensitivity (Druschel & Sherman, 1999), social conservatism (Hofstede, 1980; Thompson, 1991), and sexual strategies (Buss & Schmidt, 1993). The disease avoidance model does account for these differences. For example, females tend to be more collectivistic and religiously conservative than males, and these sex differences are fully mediated by individual differences in BIS strength (Terrizzi, Clay, & Shook, 2014).

2. Methodological problems

There are methodological issues with all three of Tybur et al.'s (2015) studies. Primarily, the validity of the social conservatism and sexual strategies measures is questionable. As such, the accuracy with which the proposed model was assessed is debatable, calling into question the reported results and their interpretation.

In studies 1 and 2, Tybur and colleagues used the sexual disgust subscale of the Three Domain Disgust Scale (TDDS; Tybur, Lieberman, & Griskevicius, 2009) to represent sexual strategies. The seven-item subscale assesses degree of disgust to situations involving sexual acts (e.g., "Performing oral sex"). None of the items, except for one (i.e., "Bringing someone you just met back to your room to have sex"), involve situations depicting the sexual strategies of promiscuity or monogamy. Thus, the subscale lacks face validity. Although sexual disgust may be correlated with measures of sexual strategies, such as the attitude subscale of the revised Sociosexual Orientation Inventory (SOI; Penke & Asendorpf, 2008) ($r = -.54$, study 3, Tybur et al., 2015), this moderate correlation should not be interpreted as assessment of the same construct. Also, as sexual and pathogen disgust are moderately correlated ($rs = .34$–$.42$; Tybur et al., 2009), and sexual behaviors are a significant source of infectious disease, controlling for sexual disgust does not rule out the hypothesis that the relation between pathogen avoidance and social conservatism is about disease avoidance.

In study 3, Tybur and colleagues included the three-item attitude subscale of the SOI as a measure of sexual strategies. However, the full SOI measure, which assesses three unique components of sociosexuality (i.e., behavior, attitudes, and desire), was not used, and the attitude subscale is the least predictive of actual future behavior, or sexual strategies (Penke & Asendorpf, 2008). Thus, across all three studies, the validity of the sexual strategies measures used by Tybur and colleagues is subject to question.

Another methodological problem is the assessment of conservatism. In studies 1 and 3, Tybur and colleagues rely on three single-item measures to assess ideology (i.e., social conservatism, economic conservatism, and political party agreement). Using single items to assess political ideology is a criticism we have previously raised (see Terrizzi et al., 2013, for a detailed discussion). Although the authors provided separate items for social and economic conservatism, these items are still very simplistic and do not assess the complexity or multidimensionality of social and economic conservatism. Furthermore, inclusion of economic conservatism and political party agreement obscures the assessment of social conservatism, which is the primary construct related to the BIS (Terrizzi et al., 2013). In study 2, measures of SDO, traditionalism, and religiosity were included with four variants of the ideology items. However, each of these measures was abbreviated scales. Thus, across all three studies, there are concerns regarding the reliability and validity of the conservatism measures.

3. Data analytic problems

As we believe that Tybur et al.'s (2015) theory is not consistent with prior research and their methodological approach did not allow for a proper test of their theory, we will not present an exhaustive critique of the authors' data analytic strategy. However, there are a few points that are important in interpreting the presented findings.

One primary concern is that Tybur and colleagues' models are overly complex. Rather than constraining their models to the most parsimonious structures possible to test their theory, they present models which estimate nearly all possible bivariate paths between their measured variables. The problems inherent in this strategy are compounded by the fact that the authors rely on model fit statistics as the primary evidence of support for their theory. Fit statistics (χ^2, CFI, RMSEA) indicate the extent to which the model fits the data. They do not necessarily provide evidence as to whether the model and the data support the proposed theory (Kline, 2005). For many fit indices (e.g., χ^2, CFI), more complex models generally produce better fit relative to less complex models built from the same data (Cheung & Rensvold, 2002; Schermelleh-Engel, Moosbrugger, & Müller, 2003). Tybur and colleagues' models are very complex relative to the proposed theory. Thus, good fit should not be mistaken for theoretical relevance.

Several analytic decisions underlie the complexity of Tybur and colleagues' models. First, the error variances between the conservatism measures were allowed to covary. Modeling the error covariances among measured variables is appropriate in limited cases, but without theoretical justification this practice simply improves the fit statistics by adding unnecessary model complexity (Kline, 2005). Tybur and colleagues do not provide justification for this analytic decision. To illustrate the impact of this modeling decision, we compared the fit statistics of all seven models as originally estimated by Tybur and colleagues[1] to

[1] The fit statistics associated with our replication of Tybur et al. (2015) models are not identical to those originally published, due to the fact that Tybur and colleagues calculated robust maximum likelihood estimates (Satorra-Bentler scaled X^2). We did not, because LISREL (v9.1) requires raw data for such calculations. We only had the covariance matrices from Tybur and colleagues' supplemental materials.

Table 2
Means, standard deviations, and bivariate correlations for all study variables.

	M	*SD*	2	3	4	5	6	7	8	9
1. PD	5.18	.95	.39***	.60***	−.10	−.21***	−.17**	.23***	.20***	.21***
2. CFS	2.34	.89		.57***	−.18***	−.25***	−.07	.34***	.30***	.26***
3. DSRC	3.04	.64			−.18***	−.33***	−.24***	.28***	.22***	.29***
4. SOI Beh	2.71	1.59				.54***	.41***	−.21***	−.21***	−.18***
5. SOI Att	4.90	2.68					.59***	−.47***	−.39***	−.47***
6. SOI Des	3.38	2.11						−.28***	−.21***	−.27***
7. RWA	3.50	1.89							.82***	.81***
8. PBS	2.54	.69								.70***
9. RF	3.79	2.59								

Notes. PD = Pathogen Disgust subscale of the Three Domain Disgust Scale; DSRC = Disgust Scale-Revised Contamination subscale; CFS = Contamination Fear Scale; SOI Beh = Behavior subscale of Sociosexual Orientation Inventory; SOI Att = Attitude subscale of Sociosexual Orientation Inventory; SOI Des = Desire subscale of Sociosexual Orientation Inventory; RWA = right-wing authoritarianism; PBS = Political Belief Scale; RF = religious fundamentalism. ***$p < .001$, ** $p < .01$.

alternate models without the estimation of covariance in the error terms (see Table 1). Removal of the error covariance specifications resulted in considerably worse fit statistics in all alternate models (significant χ^2 tests; CFI values ≤ .50; RMSEA values ≥ .40). Second, participant sex was included as a covariate. The purpose of this variable and the appropriateness of its inclusion are unclear, as Tybur and colleagues do not address sex differences in their theory. Including participant sex has the effect of controlling for sex differences, but it also adds complexity to the models without justification. Third, separate paths to all conservatism measures were included rather than using the conservatism measures as indicators of a single latent conservatism construct. The former strategy increases model complexity considerably and inflates the resulting fit statistics.

One final point of concern pertains specifically to the interpretation of the study 3 results. This is the only study in which a measure designed to assess sexual strategies (i.e., SOI Attitudes subscale) was utilized. Tybur and colleagues claim to find support that sexual strategies fully mediate the association between pathogen avoidance and conservatism based on non-significant direct effects of pathogen disgust on conservatism and significant indirect effects of pathogen disgust on conservatism through sociosexual attitudes. However, in study 3, all initial bivariate correlations between pathogen avoidance and conservatism measures were non-significant. Although establishing an initial IV → DV association is not necessary to test mediation (Zhao, Lynch, & Chen, 2009), claiming that the absence of a direct effect and presence of an indirect effect constitutes "full" mediation is debatable when there is no initial direct relation. This initial lack of a relation between pathogen avoidance and conservatism is not evidence in favor of Tybur and colleagues' theory; it is simply evidence that the authors do not have the appropriate data to test their theory.

4. Study

Given our methodological and analytic concerns with Tybur et al.'s (2015) studies, we collected data to test their proposed sexual strategies model. To address the methodological limitations, we included several well-validated and reliable measures of social conservatism and the full revised Sociosexual Orientation Inventory. With this dataset, we were able to examine the proposed model, while addressing all of the data analytic issues.

4.1. Participants and procedure

Participants were 381 individuals (M_{age} = 36.80, *SD* = 12.41; 60.3% female; 78.5% Caucasian/White, 7.9% African American/Black, 4.7% Asian, 4.5% Hispanic/Latino, .5% Native American, 1.6% biracial) recruited through Amazon's MTurk. Twenty participants (5.2%) did not report their age, nine (2.4%) did not report their ethnicity, and eight (2%) did not report their gender. Participants completed an online survey for $1.00. Measures were presented in random order.

4.2. Measures

Pathogen avoidance was assessed through the pathogen disgust subscale of the TDDS (Tybur et al., 2009; α = .81), the contamination subscale[2] of the Disgust Scale Revised (DSR; van Overveld, de Jong, Peters, & Schouten, 2011; α = .73), and the Contamination Fear subscale of the Padua Inventory (Burns, Keortge, Formea, & Sternberger, 1996; α = .91). Sexual strategies were measured using the Revised SOI (Penke & Asendorpf, 2008), which has three subscales: behavior (α = .74), attitudes (α = .87), and desires (α = .91). Conservatism was assessed with the Right-Wing Authoritarianism scale (RWA; Altemeyer, 1996; α = .96), the Religious Fundamentalism scale (RF; Altemeyer & Hunsberger, 2004; α = .97), and a Political Beliefs Scale (PBS; Shook & Clay, 2011; α = .92). Mean scores were computed for each scale with higher scores indicating greater pathogen avoidance, support for more promiscuous sexual orientations, and conservatism, respectively.

4.3. Analytic strategy

Latent variable modeling was used to test the potential mediating effect of sexual strategies on associations between pathogen avoidance and conservatism. Latent variable modeling was preferred to path analysis due to the ability to directly model measurement error (Byrne, 2001). Pathogen disgust, the DS-R contamination subscale, and contamination fear were modeled as indictors of a latent pathogen avoidance variable. The three subscales of the SOI were modeled as indicators of a latent sexual strategies variable. PBS, RWA, and RF were modeled as indicators of a latent conservatism variable. For scaling, latent variances were constrained to one (Byrne, 2001).

Procedures for testing mediation followed the steps outlined by Hopwood (2007), Little, Card, Bovaird, Preacher, and Crandall (2007), and Holmbeck (1997). The conservatism latent variable was regressed on the sexual strategies and pathogen avoidance latent variables. Additionally, the sexual strategies latent variable was regressed on the pathogen avoidance latent variable. A chi-squared difference test was used to compare two models: one with the direct effects of pathogen avoidance on conservatism constrained to zero and the second with the direct effect unconstrained. A non-significant chi-square difference test supports full mediation.

4.4. Results

Means, standard deviations, and bivariate correlations for all variables are displayed in Table 2. Measurement and structural models were estimated simultaneously, and the full model provided a good fit to the data ($\chi^2(24)$ = 58.52, CFI = .98, RMSEA = .06; see Fig. 1).

[2] One item in the DSR contamination subscale concerned a potential sexual act. To ensure this item did not amplify associations, analyses were conducted with this item removed. All significant associations and model fit comparisons were similar with and without this item included.

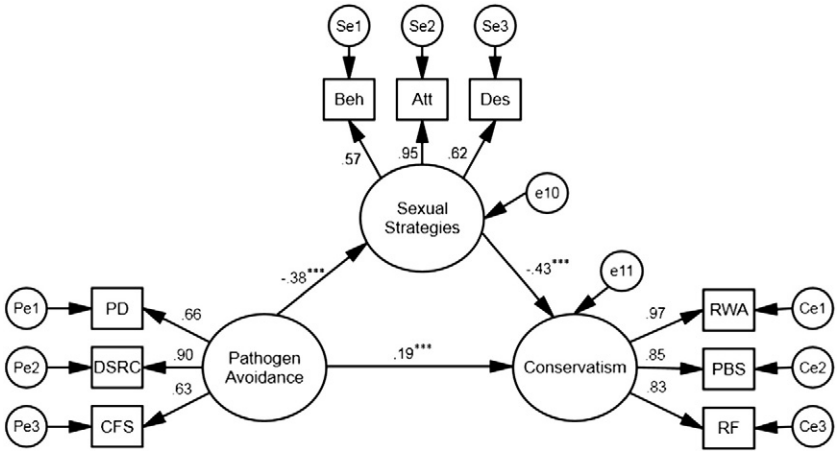

Fig. 1. Latent variable model estimating the indirect effects of pathogen avoidance on conservatism through sexual strategies. *Note.* PD = Pathogen Disgust subscale of the Three Domain Disgust Scale; DSRC = Disgust Scale-Revised Contamination subscale; CFS = Contamination Fear Scale; Beh = Behavior subscale of Sociosexual Orientation Inventory; Att = Attitude subscale of Sociosexual Orientation Inventory; Des = Desire subscale of Sociosexual Orientation Inventory; RWA = right-wing authoritarianism; PBS = Political Belief Scale; RF = religious fundamentalism. ***$p < .001$. All factor loadings were significant at $p < .001$.

Pathogen avoidance was indirectly associated with social conservatism through greater support for more monogamous sexual strategies (indirect effect: $\beta = .16, p < .001$). However, pathogen avoidance was also directly associated with conservatism ($\beta = .19$, $p < .001$). Removing the direct pathway between pathogen avoidance and conservatism resulted in a significantly worse fitting model ($\chi^2(25) = 69.85$, CFI = .97, RMSEA = .07; $\Delta\chi^2 = 11.44$, $\Delta df = 1$, $p < .001$), suggesting that sexual strategies did not fully mediate the association between pathogen avoidance and conservatism.[3]

5. General discussion

In this commentary, we have outlined several major concerns regarding Tybur et al.'s (2015) proposal that pathogen avoidance is only indirectly associated with social conservatism through sexual strategies. Theoretically, this sexual strategies explanation is limited in scope and does not address the broad range of disease threats posed by others. Furthermore, the sexual strategies model cannot account for evidence regarding the link between disease avoidance and prejudice, the association between disease prevalence rates and social conservatism, or sex differences in disgust sensitivity, social conservatism, and sexual strategies. There are also methodological and analytic issues with the data presented. Thus, the results should be interpreted cautiously. Specifically, the data may not accurately represent the proposed model variables, and the excellent model fit stems largely from analytic decisions and the complexity of the models. Furthermore, with our own data that were not limited by measurement problems, we did not find evidence to support the proposed model. Rather, the direct effect of pathogen avoidance on social conservatism remained significant, while controlling for sexual strategies.

All of this is not to say that sexual strategies are not involved in the association between pathogen avoidance and social conservatism. Sexual contact is a means of disease transmission, and indeed, we found evidence of an indirect effect of pathogen avoidance on social conservatism through sexual strategies. However, sexual contact is not the only means by which pathogens are transmitted between individuals, and the direct effect of pathogen avoidance on social conservatism remained significant in our model. Other people are a primary source of disease transmission through multiple routes, and social conservatism provides a general means of protecting the individual from exposure to pathogens by limiting contact with potentially contaminated others. Tybur and colleagues provide a limited and questionable explanation for the association between the BIS and social conservatism, which should be utilized with caution.

[3] An additional model was evaluated to ensure that discrepancies between our model and Tybur et al.'s (2015) findings were not solely due to shared variance among study variables and participant sex. This model provided an acceptable fit to the data ($\chi^2(30) = 115.60$, CFI = .95, RMSEA = .09). Controlling for sex resulted in a slightly stronger direct effect of pathogen disgust on conservatism ($\beta = .20$, $p < .001$). Model comparison statistics indicated that constraining this pathway to zero resulted in significantly worse model fit ($\Delta\chi^2 = 11.94$, $\Delta df = 1$, $p < .001$), suggesting a lack of mediation.

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http://dx.doi.org/10.1016/j.evolhumbehav.2015.06.003

References

Altemeyer, B. (1996). *The authoritarian specter.* Cambridge, MA: Harvard University Press, 374.
Altemeyer, B., & Hunsberger, B. (2004). A revised religious fundamentalism scale: The short and sweet of it. *The International Journal for the Psychology of Religion*, *14*(1), 47–54.
Burns, G. L., Keortge, S. G., Formea, G. M., & Sternberger, L. G. (1996). Revision of the Padua Inventory of obsessive compulsive disorder symptoms: Distinctions between worry, obsessions, and compulsions. *Behaviour Research and Therapy*, *34*(2), 163–173.
Buss, D. M., & Schmidt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review*, *100*, 204–232.
Byrne, B. M. (2001). *Structural equation modeling with AMOS: Basic concepts, applications, and programming.* Mahwah, NJ: Erlbaum.
Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, *9*(2), 233–255.
Clay, R., Terrizzi, J. A., & Shook, N. J. (2012). Individual differences in the behavioral immune system and the emergence of cultural systems. *Social Psychology*, *43*, 174–184.
Druschel, B., & Sherman, M. (1999). Disgust sensitivity as a function of the Big Five and gender. *Personality and Individual Differences*, *26*, 739–748.
Faulkner, J., Schaller, M., Park, J., & Duncan, L. (2004). Evolved disease-avoidance mechanisms and contemporary xenophobic attitudes. *Group Processes & Intergroup Relations*, *7*, 333–353.
Fincher, C. L., & Thornhill, R. (2012). Parasite-stress promotes in-group assortative sociality: The cases of strong family ties and heightened religiosity. *Behavioral and Brain Sciences*, *35*, 1–19.
Fincher, C. L., Thornhill, R., Murray, D. R., & Schaller, M. (2008). Pathogen prevalence predicts human cross-cultural variability in individualism/collectivism. *Proceedings of the Royal Society of London B*, *275*, 1279–1285.

Hodson, G., & Costello, K. (2007). Interpersonal disgust, ideological orientations, and dehumanization as predictors of intergroup attitudes. *Psychological Science*, *18*(8), 691–698.
Hofstede, G. (1980). *Culture's consequences: International differences in work-relate d values*. Beverly Hills, CA: Sage.
Holmbeck, G. N. (1997). Toward terminological, conceptual, and statistical clarity in the study of mediators and moderators: Examples from the child-clinical and pediatric psychology literatures. *Journal of Consulting and Clinical Psychology*, *65*(4), 599–610.
Hopwood, C. J. (2007). Moderation and mediation in structural equation modeling: Applications for early intervention research. *Journal of Early Intervention*, *29*(3), 262–272.
Inbar, Y., Pizarro, D. A., & Bloom, P. (2009). Conservatives are more easily disgusted than liberals. *Cognition and Emotion*, *23*, 714–725.
Inbar, Y., Pizarro, D. A., Knobe, J., & Bloom, P. (2009). Disgust sensitivity predicts intuitive disapproval of gays. *Emotion*, *9*, 435–439.
Kline, Rex B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: The Guilford Press.
Little, T. D., Card, N. A., Bovaird, J. A., Preacher, K. J., & Crandall, C. S. (2007). Structural equation modeling of mediation and moderation with contextual factors. In T. D. Little, J. A. Bovaird, & N. A. Card (Eds.), *Modeling contextual effects in longitudinal studies* (pp. 207–230). Mahwah, NJ: Lawrence Erlbaum Associates.
Navarrete, C. D., & Fessler, D. M. T. (2006). Disease avoidance and ethnocentrism: The effects of disease vulnerability and disgust sensitivity on intergroup attitudes. *Evolution and Human Behavior*, *27*, 270–282.
Park, J. H., Schaller, M., & Crandall, C. S. (2006). *Psychological disease-avoidance mechanisms and stigmatization of fat people*. Unpublished manuscript The Netherlands: University of Groningen.
Penke, L., & Asendorpf, J. B. (2008). Beyond global sociosexual orientations: A more differentiated look at sociosexuality and its effects on courtship and romantic relationships. *Journal of Personality and Social Psychology*, *95*(5), 1113–1135.
Schaller, M. (2006). Parasites, behavioral defenses, and the social psychological mechanisms through which cultures are evoked. *Psychological Inquiry*, *17*(2), 96–137.
Schaller, M., & Duncan, L. A. (2007). The behavioral immune system: Its evlolution and social psychological implications. In Forgas, Haselton, & von Hippel (Eds.), *Evolution and the social mind: Evolutionary psychology and social cognitions* (pp. 293–307). New York: Psychology Press.
Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, *8*(2), 23–74.
Shook, N. J., & Clay, R. (2011). Valence asymmetry in attitude formation: A correlate of political ideology. *Social Psychological and Personality Science*, *2*(6), 650–655.
Terrizzi, J. A., Jr., Clay, W. R., & Shook, N. J. (2014). Does the behavioral immune system prepare females to be religiously conservative and collectivistic? *Personality and Social Psychology Bulletin*, *40*, 189–202.
Terrizzi, J. A., Jr., Shook, N. J., & McDaniel, M. A. (2013). The behavioral immune system and social conservatism: A meta-analysis. *Evolution and Human Behavior*, *34*, 99–108.
Terrizzi, J. A., Jr., Shook, N. J., & Ventis, W. L. (2010). Disgust: A predictor of social conservatism and prejudicial attitudes toward homosexuals. *Personality and Individual Differences*, *49*, 587–592.
Terrizzi, J. A., Jr., Shook, N. J., & Ventis, W. L. (2012). Religious conservatism: An evolutionarily evoked disease-avoidance strategy. *Religion, Brain & Behavior*, *2*, 105–120.
Thompson, E. H. (1991). Beneath the status characteristic: Gender variations in religiousness. *Journal for the Scientific Study of Religion*, *30*, 381–394.
Thornhill, R., & Fincher, C. L. (2014). The parasite-stress theory of sociality, the behavioral immune system, and human social and cognitive uniqueness. *Evolutionary Behavioral Sciences*, *8*(4), 257–264.
Tybur, J. M., Inbar, Y., Güler, E., & Molho, C. (2015). Is the relationship between pathogen avoidance and ideological conservatism explained by sexual strategies? *Evolution and Human Behavior*, *36*, 489–497.
Tybur, J. M., Lieberman, D., & Griskevicius, V. (2009). Microbes, mating, and morality: Individual differences in three functional domains of disgust. *Journal of Personality and Social Psychology*, *97*(1), 103–122.
Tybur, J. M., Merriman, L. A., Caldwell Hooper, A. E., McDonald, M. M., & Naverrete, C. D. (2010). Extending the behavioral immune system to political psychology: Are political conservatism and disgust sensitivity really related? *Evolutionary Psychology*, *8*, 599–616.
van Overveld, M., de Jong, P. J., Peters, M. L., & Schouten, E. (2011). The Disgust Scale-R: A valid and reliable index to investigate separate disgust domains? *Personality and Individual Differences*, *51*(3), 325–330.
Zhao, X., Lynch, J. G., & Chen, Q. (2009). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *The Journal of Consumer Research*, *37*, 197–206.

Pathogen disgust requires no defense: a response to Shook, Terrizzi, Clay, & Oosterhoff (2015)

We thank Shook, Terrizzi, Clay, and Oosterhoff (STCO) for their careful reading of our paper (Tybur, Inbar, Güler, & Molho, 2015). We will briefly address their statistical critiques, which are specific to our paper, before commenting on issues of measurement and theory, which are relevant to this broader literature.

1. Statistical analyses

STCO criticize our analytic strategy on multiple fronts. First, they object to our modeling of error covariances between endogenous ideology variables in path analyses. Failing to model error covariances assumes that conservatism measures are completely uncorrelated, except to the extent to which they are related to model predictors. As STCO demonstrate, models of this assumption fit the data poorly. The fit of such models is irrelevant to the theory being tested in our article or STCO's response, though—it merely demonstrates that, say, social conservatism correlates with agreement with the Republican Party. Second, after previously objecting to using measures that blend economic and social conservatism (Terrizzi, Shook, & McDaniel, 2013), STCO curiously criticize us for not blending our diverse conservatism measures into a single latent variable. STCO's proposal will be difficult to evaluate empirically if it can neither be tested by treating social and economic conservatism separately nor by averaging across social and economic conservatism. Finally, STCO object to our use of the routine practice of interpreting model fit statistics for theory testing; this criticism is especially peculiar given STCO later employee these same fit statistics in their analyses. On the whole, STCO's statistical critiques do not warrant change to our conclusions.

Nevertheless, to satisfy STCO's concerns regarding path models, we reanalyzed every relationship reported in our paper using the simplest mediation model possible. Using SPSS's PROCESS macro, we tested direct and indirect effects of pathogen avoidance on conservatism, mediated by sexual strategies. Across every measure in all three studies, we observe no direct relationship between pathogen avoidance and conservatism, though pathogen avoidance does consistently relate to conservatism indirectly via sexual strategies (see Table 1 for effects for "social" conservatism variables). Since publishing our paper, we have included the TDDS and the item "How would you describe your political orientation when it comes to social issues" in two studies (N's = 347 and 490) using Mechanical Turk participants, the same group sampled in our manuscript and in STCO's commentary. In both data sets, we observe an indirect relationship of pathogen disgust on social conservatism via sexual disgust, but no direct relationship between pathogen disgust and social conservatism (see Table 1). In sum, across five large samples, we find that sexual disgust fully mediates any relationship between pathogen disgust and social conservatism. Even so, do these measures offer a fair test of the theories we and STCO describe?

2. Measurement

STCO's primary measurement critiques concern (1) our treatment of the TDDS sexual disgust subscale as a measure of sexual strategies and (2) our choice of conservatism measures. The first criticism exemplifies the so-called jangle fallacy (Uher, 2011)—assuming that two instruments measure different constructs based on surface level differences rather than empirical validation. Here's what we know about TDDS sexual and a widely used measure of sexual strategies, the SOI: The two instruments show similar relationships with Big Five and HEXACO personality instruments (Bourdage, Lee, Ashton, & Perry, 2007; Tybur, Bryan, Lieberman, Caldwell Hooper, & Merriman, 2011; Tybur & de Vries, 2013), respondent sex (compare Tybur & de Vries, 2013, and Tybur et al., 2011 with Schmitt, 2005), and attitudes toward recreational drug use, an issue strongly related to social conservatism (Kurzban, Dukes, & Weeden, 2010). In study 3 of our paper, the two variables were correlated − .54 (−.63 after disattenuating for unreliability), and they correlated almost identically with social conservatism (r's = .26 and − .23, respectively). Of course, the SOI and TDDS sexual likely do not measure identical constructs, but protests against using the latter as a measure of sexual strategies based solely on a subjective reading of item content are not compelling.

STCO's criticisms of single-item measures of social and economic ideology are likewise uncompelling. Single-item measures of ideology, which are commonly employed in political psychology, predict attitudes and behavior well (Jost, 2006). Further, multiple-item measures