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Original Article

The behavioral immune system and social conservatism: a meta-analysis

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ABSTRACT

The behavioral immune system (BIS) is a cluster of psychological mechanisms (e.g., disgust) that have evolved to promote disease-avoidance (Schaller M. (2006). Parasites, behavioral defenses, and the social psychological mechanisms through which cultures are evoked. *Psychological Inquiry*, 17, 96–101). Recent evidence suggests that the BIS may promote avoidance of outgroup members, an historical source of contamination, by evoking social conservatism (Terrizzi JA Jr, Shook NJ, & Ventis WL. (2010). Disgust: A predictor of social conservatism and prejudicial attitudes toward homosexuals. *Personality and Individual Differences*, 49, 587–592; Terrizzi J, Shook N, Ventis L. (2012). Religious conservatism: An evolutionarily evoked disease-avoidance strategy. *Religion, Brain & Behavior*, 2, 105–120.). That is, the BIS mechanisms may encourage the endorsement of socially conservative beliefs, which promote social exclusivity, tradition, and negativity toward outgroups. The current study provides a systematic review and meta-analysis of 24 studies to evaluate the hypothesis that the BIS is predictive of social conservatism. The results indicate that behavioral immune strength, as indicated by fear of contamination and disgust sensitivity, is positively related to social conservatism (i.e., right-wing authoritarianism, social dominance orientation, religious fundamentalism, ethnocentrism, collectivism, and political conservatism). These findings provide initial evidence that socially conservative values may function as evolutionarily evoked disease-avoidance strategies.

1. Introduction

Historically, infection and disease have posed adaptive challenges for humans. In order to overcome these evolutionary hurdles, humans are equipped with both a biological immune system, which removes contaminants once they have entered the body, and a behavioral immune system (BIS), which is composed of psychological mechanisms that encourage disease-avoidance (Schaller, 2006). The adaptive advantage of the BIS is that it promotes prophylactic behavior, providing organisms with a first line of defense against contamination. If an organism has a sensitive or reactive BIS, it would not have to use the valuable resources that the biological immune system requires. As other people are a significant source of infectious disease, the BIS has important implications for social interaction and may play an important role in the emergence of culture. The current paper provides a systematic meta-analysis of the existing data to evaluate whether individual differences in the BIS are predictive of adherence to socially conservative value systems (i.e., ideological systems that promote ingroup homogeneity and outgroup avoidance).

1.1. Behavioral immune system

Activation of the BIS occurs when individuals are exposed to sensory information that is indicative of potential contamination, i.e., gustatory (e.g., sour milk), olfactory (e.g., garbage), auditory (e.g., clearing throat), visual (e.g., vomit), or tactile (e.g., sticky substance) input. Stimuli that resemble substances which can transmit disease (e.g., vomit, urine, feces, pus, and blood) are particularly effective elicitors of BIS activation (Curtis & Biran, 2001; Curtis, Aunger, & Rabie, 2004). In reaction to such stimuli, the BIS automatically induces adaptive affective (e.g., disgust), cognitive (e.g., thoughts of contamination), and behavioral (e.g., avoidance) responses that promote disease-avoidance. In other words, the BIS encourages individuals to avoid situations that could lead to contamination. One of the primary mechanisms of the BIS is disgust, a cross-culturally recognized emotion that invokes feelings of revulsion when individuals are exposed to repulsive stimuli (Ekman, 1970). Disgust serves a protective function by indicating that a specific stimulus may pose a disease-threat and should be avoided (Curtis & Biran, 2001; Faulkner, Schaller, Park, & Duncan, 2004; Navarrete & Fessler, 2006; Oaten, Stevenson, & Case, 2009).

Although the BIS is conceptualized as a cluster of adaptive disease-avoidance mechanisms, there is significant variability in BIS sensitivity and reactivity. The BIS is not simply a system that an individual either has or does not have, but rather a system that varies in strength across individuals. Thus, the BIS, can be assessed as a chronic personality trait.

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People who have a strong BIS are preoccupied with thoughts of contamination and are prone to Type I errors (i.e., perceiving something as a disease threat when it is not). Consequently, the cost of a strong BIS is that potentially viable resources will be neglected due to fear of contamination, whereas the benefit is reduced exposure to disease. On the other hand, people with a weak BIS may be less likely to miss out on valuable resources but more likely to be exposed to deadly contagions. However, some exposure to infectious disease can have long-term immunological benefits such as increasing immunological memory. Measures of individual differences in the BIS include the perceived vulnerability to disease scale, (PVD; Duncan, Schaller, & Park, 2009), the three domain disgust scale (Tybur, Lieberman, & Griskevicius, 2009), and the disgust sensitivity scale (Haidt, McCauley, & Rozin, 1994).

The BIS has implications for social interactions and intergroup attitudes. As long as humans have lived in groups, they have shared diseases. Other people, especially outgroup members who may harbor novel pathogens, are potential sources of infectious disease. As such, Schaller and Duncan (2007) have argued that the BIS should encourage individuals to prefer ingroup members over outgroup members. Indeed, researchers have demonstrated that the BIS as indexed by PVD is correlated with negative attitudes toward outgroups including individuals who are disabled, obese, or foreign (Park, Faulkner, & Schaller, 2003; Faulkner et al., 2004; Navarrete & Fessler, 2006; Park, Schaller, & Crandall, 2006). Likewise, disgust sensitivity has been correlated with prejudice toward homosexuals using both explicit and implicit measures (Inbar, Pizarro, Knobe, & Bloom, 2009; Olatunji, 2008; Terrizzi, Shook, & Ventis, 2010). Moreover, activating the BIS (e.g., priming disease-threat) increases negative attitudes toward outgroups and increases positive attitudes toward the ingroup (Faulkner et al., 2004; Navarrete & Fessler, 2006). Together, these results suggest that BIS strength and activation of the BIS encourage individuals to exhibit positivity toward ingroup members and negativity toward outgroup members.

Beyond intergroup attitudes, the BIS may have broader socially relevant correlates, which have implications for the emergence of culture. More specifically, the BIS may prepare individuals to avoid potentially contaminated outgroups by facilitating the adoption of sociocultural value systems that promote ingroup homogeneity and outgroup exclusion. Theoretically, those who have a stronger BIS may be more likely to endorse socially conservative values that result in smaller, more cohesive and less diverse ingroups.

1.2. Social conservatism

Social conservatism can be defined broadly as any sociocultural value system that encourages strict adherence to social norms and emphasizes social exclusivity. Individuals who adopt such value systems are devoted to social conventions and traditions, which function as a means of promoting ingroup cohesion (Altemeyer, 1988). Adherence to social norms helps to ensure that ingroup members do not behave in ways that are contrary to the group's best interest and helps to distinguish ingroup members from outgroup members (Triandis, 1994). Social conservatives have little tolerance for individuals who deviate from social conventions. Thus, they are more discriminating in terms of who they consider an ingroup member, resulting in a narrower ingroup and a more diverse outgroup (Gudykunst, Gao, Schmidt, Nishida, et al., 1992).

Right-wing authoritarianism (RWA) and social dominance orientation (SDO) are examples of socially conservative value systems. RWA is an adherence to tradition, submission to authority, and aggression toward outgroup members (Altemeyer, 1988). Similarly, SDO is an individual's belief in a hierarchical social structure (Pratto, Sidanius, Stallworth, & Malle, 1994). Both of these belief systems are similar in that they promote ingroup cohesion and negativity toward outgroup members. A meta-analysis demonstrated that they are both consistently, positively correlated with prejudice toward outgroups including ethnic and sexual minorities (Sibley & Duckitt, 2008).

Cultural value systems can also promote social conservatism. Collectivism emphasizes strict adherence to social norms, or social conservatism, whereas individualism promotes autonomy and independence (Triandis, 1994). More recently, collectivism has been divided into horizontal and vertical subtypes. In cultures that exhibit horizontal collectivism, group members are seen as equals, whereas vertical collectivism is more socially conservative in that it emphasizes social hierarchies (i.e., some individuals are better than others; Singelis, Triandis, Bhawuk, & Gelfand, 1995). Collectivism, like other forms of social conservatism, promotes an increased ingroup bias. For example, collectivism encourages increased within group reciprocity but not between group reciprocity (Yamagishi, Jin, & Miller, 1998) and greater discrimination between ingroup and outgroup members (Gudykunst et al., 1992).

Social conservatism can also be described as a strict adherence to specific value systems (e.g., religious conservatism, ethnocentrism, political conservatism). For example, religious conservatism is a dogmatic allegiance to a specific religious worldview including adherence to religious texts, doctrines, and rituals. It is characterized by a general intolerance for alternative worldviews and has long been known to correlate with prejudice toward outgroup members (Altemeyer & Hunsberger, 2004). Furthermore, the relation between religious conservatism and prejudice is mediated by social conservatism (e.g., RWA), suggesting that it is the socially conservative nature of religious conservatism that promotes prejudice (Laythe, Finkel, & Kirkpatrick, 2001).

Likewise, social conservatism may manifest itself in terms of ethnocentrism, a value system in which individuals believe that their ethnic group is inherently superior to other groups. For example, American ethnocentrism is associated with ingroup bias (e.g., patriotism) and negative attitudes toward foreign others (Neuliep & McCroskey, 1997; Navarrete & Fessler, 2006). Another form of social conservatism may be political conservatism. However, it is important to note that there are two types of political conservatism: social/cultural conservatism, which is associated with dogmatism and adherence to tradition, and economic conservatism (Johnson & Tamney, 2001). Although social conservatism and economic conservatism are positively correlated, social conservatism is more relevant to social injustices such as prejudice whereas economic conservatism is concerned with distribution of wealth (Jost, Federico, & Napier, 2009). Thus, social, not economic, political conservatism is relevant to the current discussion. Politically conservative social attitudes (e.g., conservative attitudes toward immigration) are more indicative of social conservatism and have implications for group norms and intergroup interactions. Indeed, political conservatism has been positively correlated with prejudice toward African Americans and homosexuals (Sears & Henry, 2003; Terrizzi et al., 2010).

The evidence presented here suggests that social conservatism can take a variety of forms including RWA, SDO, collectivism, religious fundamentalism, ethnocentrism, and political conservatism. These forms of social conservatism function as a means of promoting ingroup cohesion and cooperation (Yamagishi et al., 1998), as well as encouraging avoidance of and prejudice toward outgroup members (Gudykunst et al., 1992; Neuliep & McCroskey, 1997; Sears & Henry, 2003; Altemeyer & Hunsberger, 2004; Sibley & Duckitt, 2008; Terrizzi et al., 2010). Thus, social conservatism may function as a social strategy that promotes adherence to traditions and norms, sharp boundaries between ingroup and outgroup members, and avoidance of and negativity toward outgroup members.

1.3. BIS and social conservatism

The primary function of the BIS is to encourage individuals to avoid potential sources of contamination. One potential source of

contamination is other people, especially outgroup members. Socially conservative value systems endorse social exclusivity and the avoidance of outgroup member. Thus, if the BIS protects against possible contamination from outgroup members, BIS strength should be correlated with a broad range of socially conservative value systems which promote the avoidance of potentially contaminated outgroup members. Indeed, evidence indicates that the BIS may encourage avoidance of outgroup members via socially conservative values. For example, Terrizzi et al. (2010) showed that BIS strength is predictive of socially conservative value systems (e.g., RWA, religious fundamentalism) and that activation of the BIS for social conservatives, but not social liberals, increased prejudice toward homosexuals.

Additionally, other research indicates that the relation between the BIS and prejudice toward outgroups is at least partially mediated by social conservatism (e.g., Hodson & Costello, 2007; Olatunji, 2008; Terrizzi, Shook, & Ventis, 2012). More specifically, Hodson and Costello (2007) demonstrated that SDO and RWA mediated the relation between interpersonal disgust and negative attitudes toward foreigners. Similarly, Olatunji (2008) and Terrizzi et al. (2012) demonstrated that religious conservatism mediates the relation between disgust sensitivity and prejudice toward sexual minorities.

Furthermore, evidence suggests that BIS strength is predictive of a wide variety of socially conservative value systems and related personality constructs. Disgust sensitivity and disease prevalence are related to individual differences in openness to experience and sociosexuality, both of which are negatively related to social conservatism (Druschel & Sherman, 1999; Schaller & Murray, 2008). Disgust sensitivity has also been related to political conservatism (Inbar, Pizarro, & Bloom, 2009), religious obsessions (e.g., fear of sin; Olatunji, Tolin, Huppert, & Lohr, 2005), and religious conservatism (Terrizzi et al., 2012). More recent evidence has indicated that historic disease prevalence is predictive of collectivism (Fincher, Thornhill, Murray, & Schaller, 2008) and that BIS strength is predictive of vertical collectivism (Holtz, Gordon, Craney, & Stafford, 2007; Clay, Terrizzi, & Shook, in press). Together, these findings provide preliminary evidence indicating that BIS strength is associated with a wide range of socially conservative value systems.

1.4. Current research

Although previous papers have reviewed the social implications of the BIS (e.g., Schaller & Park, 2011), there has not been a comprehensive review of the relation between the BIS and social conservatism. The purpose of the current research was to provide a statistical summary of the research that has examined the relation between BIS strength and social conservatism. A comprehensive review and meta-analysis were performed to achieve this objective. If social conservatism is an evolutionarily evoked disease-avoidance strategy, trait-level differences in the BIS should be positively correlated with social conservatism. In other words, individuals who have a strong BIS are expected to exhibit higher levels of social conservatism than individuals who have a weak BIS system.

2. Method

2.1. Literature search

Both published and unpublished research were included in the meta-analysis. Published research was obtained by conducting searches within PsychINFO. The search terms that were used for the literature review can be found in Table 1 with final hit counts as of April 2011. In addition to the search terms, the databases were also searched for studies that used measures that could be considered indicators of the BIS. The references of the studies that were attained via the initial literature review were then examined to find additional studies. Unpublished and in press research was sought using two different methods. First, a message was posted on the Society for Personality and Social Psychology's listserv requesting unpublished research that was relevant to the topic. Second, an email requesting published and unpublished data was sent to researchers who have published studies on topics that relate to the BIS.

Table 1
Search Terms and Number of Hits Returned from PsychINFO.

Search terms	# of Hits
Behavioral Immune System	4
Disease Avoidance	43
Disgust AND Avoidance	136
Disgust AND Conservatism	6
Disgust AND Outgroup	15
Disgust AND Prejudice	30
Disgust AND Religious	26
Fear of Contamination	61
Perceived Vulnerability to Disease	16

Because this is a relatively new field, the definitions of the BIS and social conservatism were necessarily broad. For the purposes of this study, the BIS was defined as a cluster of psychological mechanisms that are designed to promote disease-avoidance (Schaller, 2006). The BIS measures that were considered included both behavioral/cognitive measures that assess thoughts of contamination and disease-avoidance and affective measures that assess sensitivity to disgust (see Table 2). For studies that contained multiple measures of BIS strength, only one measure was included in the meta-analysis in order to avoid inflating the probability of a Type I error. The measures appear in the order in which they were chosen. The PVD was chosen first because it is the most commonly used measure of BIS strength (Duncan et al., 2009). If available, the germ aversion subscale of the PVD was used because it assesses disease-avoidance whereas the perceived infectability subscale is an indicator of biological immune strength. If the PVD was not available, measures of general disgust sensitivity (i.e., Disgust Scale-Revised; Olatunji et al., 2007) where used to indicate BIS strength. Finally, if neither the PVD nor a measure of general disgust sensitivity were available, the pathogen disgust subscale of the Three Domain Disgust Scale was used (Tybur et al., 2009).[1] All of the BIS measures had moderate to strong positive correlations with *r*s ranging from .43 to .67 (see Olatunji et al., 2005; Duncan et al., 2009; Terrizzi et al., 2012).

Social conservatism (SC) was defined broadly as any belief system that encourages strict adherence to social norms and social exclusivity. The measures of social conservatism that were considered in this meta-analysis are listed in Table 2. They are also listed in the order in which they were chosen to be included in the meta-analysis. The measures of SC could be divided into 6 categories: RWA, SDO, vertical collectivism, religious conservatism, ethnocentrism, and political conservatism. RWA was the preferred measure because it is the most general measure of SC assessing authoritarian submission, aggression toward outgroups, and conventionalism. If RWA was not used, measures of SDO and Vertical Collectivism were preferred as general measures of conservative beliefs, hierarchy, and group based superiority. If general measures of SC were not available, indicators of religious conservatism, ethnocentrism, and political conservatism were considered. Political conservatism was the least preferred indicator of SC because there are two types of political conservatism: economic conservatism (e.g., attitudes toward taxes) and social conservatism (e.g., attitudes toward social policies such as immigration). All of the measures of social conservatism were moderately to

[1] The general disgust measures were preferred over the pathogen disgust scale because they assess both sexual and pathogen/core disgust, which are both disease-avoidant components of disgust.

Table 2
Measures of Behavioral Immune Strength and Social Conservatism with Cronbach's αs.

Measure		α
BIS measures	Perceived Disease Vulnerability Scale (Duncan et al., 2009)	.82
	Disgust Scale-Revised (Olatunji et al., 2007)	.87
	Disgust Scale (Haidt et al., 1994)	.89
	Pathogen Subscale of the Three Domain Disgust Scale (Tybur et al., 2009)	.84
SC measures	Right-Wing Authoritarianism (Altemeyer, 1988)	.95
	Social Dominance Orientation (Pratto et al., 1994)	.74
	Vertical Collectivism (Singelis et al., 1995)	.68
	Religious Fundamentalism (Altemeyer & Hunsberger, 2004)	.95
	Religious Orthodoxy (Batson, Schoenrade, & Ventis, 1993)	.97
	The Penn Inventory of Scrupulosity (Abramowitz, Huppert, Cohen, Tolin, & Cahill, 2002)	.93
	American Ethnocentrism Scale (Neuliep & McCroskey, 1997)	.92
	Political Conservatism Scale (Terrizzi et al., 2010)	.80

strongly correlated with *r*s ranging from .30 to .76 (see Sibley & Duckitt, 2008; Terrizzi et al., 2010, 2012; Clay et al., in press).

The purpose of the current meta-analysis was to identify whether trait levels of BIS strength are predictive of social conservatism. Thus, only correlational studies were considered in the current meta-analysis. Studies that manipulated the BIS and/or assessed changes in social conservatism were not included (e.g., Park et al., 2003; Faulkner et al., 2004; Navarrete & Fessler, 2006; Park et al., 2006). However, only a few studies have examined experimental activation of the BIS in relation to social conservatism, and those studies have only focused on one form of social conservatism – ethnocentrism (i.e., Faulkner et al., 2004; Navarrete & Fessler, 2006).

From the literature searches, 14 papers were identified, which contained a total of 24 studies which fit the criteria of this meta-analysis. Only one measure of BIS and SC were used from each study. If a study used more than one of the BIS or SC measures, we selected measures based on the BIS and SC measure orderings described in the previous sections.

Studies were coded for bibliographical information such as authors, year, and publication status (i.e., published vs. unpublished), as well as methodological information such as sample size and the type of BIS and SC measure. As previous research has found a sex difference in disgust sensitivity (e.g., Druschel & Sherman, 1999), the percent of males in the sample was also coded. Finally, correlation coefficients were coded as the effect size measure.

2.1.1. Statistical methods

A psychometric meta-analysis was conducted following the Hunter and Schmidt (2004) method using a SAS macro designed by McDaniel (2010). The psychometric meta-analysis was performed because it corrects for attenuation due to measurement error and provides an estimate of the population distributions mean and variance at the construct level (i.e., the correlation between BIS and SC was estimated for a population distribution in which both BIS and SC were assessed without measurement error). The reliability estimates used to correct for measurement error were taken from the samples that provided the BIS and SC correlations. If not reported, the reliabilities were retrieved from the parent articles of the measures. For single-item measures, the reliabilities were estimated using the Spearman-Brown formula (Williams, McDaniel, & Nguyen, 2006). Specifically, for the Faulkner et al. (2004) studies that used a single item measure of ethnocentrism, we used the American Ethnocentrism Scale (Neuliep & McCroskey, 1997), which has 16 items and a reliability of .92. Applying the Spearman-Brown formula, we estimated that the one item measure from Faulkner et al. (2004) had a reliability of .42. For the Tybur, Merriman, Caldwell Hooper, McDonald, and Naverrete (2010) Study 1 and Inbar, Pizarro, Iyer, and Haidt (2012) Studies 1 and 2, which used a single item measure of political conservatism, we used a political conservatism scale (Terrizzi et al., 2010) which has 14 items and a reliability of .80. Applying the Spearman-Brown formula, we estimated that the one item measure of political conservatism had a reliability of .64.

In addition to the psychometric meta-analysis, an alternative analysis using the Hedges and Olkin (1985; Borenstein, Hedges, Higgins, & Rothstein, 2009) method, which typically does not incorporate reliability corrections, was also conducted. Because the Hedges and Olkin analysis does not correct for unreliability, it provides an underestimate of the BIS and SC population correlation. This analysis is offered as a sensitivity analysis (Greenhouse & Iyengar, 2009) to evaluate the extent to which our results and conclusions are consistent across analysis approaches. The Hedges and Olkin analyses were performed using Comprehensive Meta-Analysis (CMA; Borenstein, Hedges, Higgins, & Rothstein, 2005). Given the proposed sex moderator and the construct variation across studies due to different measures being used across studies, a random effects model was conducted for both the Hedges and Olkin tradition analyses and the psychometric meta-analyses.[2] The random effects model accounts for variability between studies that could be due to moderators.

As an additional sensitivity analysis, we provide a hybrid analysis that combines the psychometric meta-analysis method and the Hedges and Olkin method (1985; Borenstein, Hedges, Higgins, & Rothstein, 2009). For the hybrid analysis, the observed correlations were corrected for unreliability and analyzed using CMA.[3] The use of corrected correlations in CMA permitted us to conduct publication bias analyses on both the observed (uncorrected) correlations and the estimated population correlations (correlations corrected for measurement error and range restriction). These publication bias analyses constituted a set of sensitivity analyses designed to evaluate the robustness of conclusions to the threat of publication bias.

Heterogeneity is variance which cannot be readily attributed to random sampling error. The heterogeneity of the effect sizes were examined using Q, I^2 (Borenstein et al., 2009), and credibility intervals (Hunter & Schmidt, 2004). The Q statistic provides a statistical significance test, such that a significant Q indicates significant variance across studies. The I^2 statistic provides an estimate of the proportion of variance that is due to the variability in true effect sizes across studies. (Higgins, Thompson, Deeks, and Altman (2003) criteria were used to evaluate the I^2: 25% is low, 45% is moderate, and 75% is large. Credibility intervals, unlike confidence intervals which are used to evaluate the sampling error associated with an effect size estimate, are indicative of the distribution of true effects (Whitener, 1990). Large credibility intervals suggest that there is reason to believe that there is a moderator.

Moderation analyses were conducted in CMA using both the observed and corrected correlations to determine whether the size of the effect was consistent across measures of the BIS and social conservatism. Specifically, two separate analyses were conducted to determine whether the relation varied across 1) measures of BIS strength and 2) measures of social conservatism. If there is no significant moderation due to the types of BIS and social conservatism measures, it would suggest that the relation between BIS and social conservatism is robust to the manner in which BIS and SC are measured. Heterogeneity was evaluated within moderator sub-groups to determine whether there was any significant moderator variation.

Also, studies have suggested that females are more sensitive to disgust than males (Druschel & Sherman, 1999). Some evidence suggests that females are more likely to experience specific forms of social conservatism (e.g., religious conservatism and collectivism;

[2] Psychometric meta-analysis is always a random effect meta-analysis.

[3] The corrected correlations input into the CMA program were accompanied by the corrected standard errors. The corrected standard error is estimated as the observed correlation standard error multiplied by the ratio of the estimated corrected correlation to the observed correlation (Lipsey & Wilson, 2001).

Francis, 1997). Thus, it may be that the relation between BIS and SC is stronger for females than males. In order to test this hypothesis, we conducted a meta-regression in which sex was defined as the percent of males in the sample.

To test for publication bias, we conducted several additional sensitivity analyses. First, we examined whether study correlations co-varied with publication source (i.e., published or unpublished). This was achieved by conducting a simple moderation analysis to determine whether the studies that were published exhibited a significantly larger summary effect size compared with studies that were not published. Although this analysis is informative, it is insufficient as a publication bias analysis. The analysis assumes that the published studies are representative of all published studies and that the unpublished studies are representative of all unpublished studies. Neither assumption is likely to be true (Hopewell, Clarke, & Mallett, 2005; Ferguson & Brannick, 2012). Alternative approaches to testing for publication bias such as Duval and Tweedie's (2000) trim and fill procedure allow researchers to impute missing data. The trim and fill analysis is based on a funnel plot (i.e., a plot of the magnitude of the effect sizes relative to the precision of the effect sizes). The procedure evaluates the symmetry of the effect sizes, and if asymmetrical, studies are imputed. One compares the mean effect of the observed data with the mean effect based on both the original and imputed data. To the extent that the means differ, one may conclude that there is publication bias in the literature.[4]

Additionally, in some literatures, it appears that the earliest published effect sizes are larger, on average, than later published effect sizes (Trikalinos & Ioannidis, 2005). This finding may be due to a time-lag bias, such that the time to publication is shorter for statistically-significant effects than for smaller magnitude or statistically nonsignificant effects (Stern & Simes, 1997; Ioannidis, 1998; Trikalinos & Ioannidis, 2005). A time-lag bias can be identified by performing a cumulative meta-analysis, in which effect sizes are sorted by a variable of interest (e.g., year of publication), and the meta-analysis is conducted repeatedly each time adding an additional effect size. Sorting by time permits an evaluation of a time lag bias. Because the BIS and SC literature is relatively new and generating substantial interest, the literature may have been affected by a time-lag bias.

In addition to the time-lag bias, there may also be a bias such that the effect size varies as a function of precision (i.e., standard error). If the mean effect sizes drift as lower precision studies are added, it suggests that the lower precision studies in the meta-analysis may not be representative of all lower precision studies. For example, small sample studies with small magnitude correlations may be missing from the data set available to the reviewer. This bias can be identified by conducting a cumulative meta-analysis in which studies are sorted by standard error (i.e., more precise studies added first). An inspection of the cumulative means reveals whether the studies vary as a function of precision.

Another potential bias that can occur with a meta-analysis is that a single study may inordinately influence the summary effect size. In other words, an outlier may bias the estimate of the true effect. A final sensitivity analysis was conducted to test for this bias evaluating the mean effect size as a function of dropping effects. One approach used was conducting the analyses multiple times each time dropping a different effect size. If the means are substantially the same, one can infer that no single study unduly affected the results and conclusions. A second approach is to drop effect sizes "for cause." For example, one might drop effect sizes because of issues that might cause them to be outliers that unduly affect results.

3. Results

3.1. Primary analysis

The observed correlations and the estimated population correlations (corrected for measurement error) for all 24 studies are presented in Table 3. All of the correlations are in the expected direction (i.e., positive) and are relatively variable ranging from .02 to .49 for the uncorrected correlations and .04 to .78 for the corrected correlations. The three lowest correlations, Smith, Oxley, Hibbing, Alford, and Hibbing (2008) and Tybur et al. (2010) Studies 1 and 2, were from studies examining the relation between BIS and political conservatism. The small correlations (.03 and .06) from the Tybur et al. (2010) studies, which are significantly lower than the next lowest correlation (.19), may be due to the fact that a single item measure of political conservatism was used in Study 1 and four items that asked similar questions (e.g., I consider myself to be politically liberal) were used in Study 2. This is problematic because such measures fail to distinguish between social and economic conservatism, particularly as the BIS should only be correlated with social conservatism.

The summary effects for all of the models are presented in Table 4. The results indicate that there is a moderate relation between the BIS and SC. The summary effects range from .24 to .31. The I^2 value for the Hedges and Olkin (1985) model indicates that there is moderate to large variation in the effect sizes ($I^2 = 66.30$). The I^2 values for the Hunter and Schmidt (2004) model ($I^2 = 58.21$)[5] and for the hybrid analysis both suggest a similar heterogeneity in effect sizes ($I^2 = 60.94$). Additionally, the 95% credibility interval for the fully-corrected psychometric model is also large ($CR_{.95} = .16, .44$). Together, these results suggest that there is moderate variation in the effect sizes and that moderation analyses should be pursued.

3.2. Moderation analyses

Results of the moderation analyses are reported in Table 5. Initially, the results indicated that the effect was moderated by BIS measure. The strength of the effect appeared to be stronger for perceived vulnerability to disease than disgust. However, when the political conservatism studies were removed from the distribution of BIS measures, there was no evidence of moderation. These results indicate that the relation between BIS and SC is consistent across measures of BIS strength.

The moderation analysis for SC suggested that SC measures significantly moderated the relation between BIS and SC. An initial analysis suggested that the relation between BIS and political conservatism ($r = .19$) was significantly weaker than relations between BIS and the other measures ($rs = .34$-$.42$). However, when the studies that measured political conservatism with a single self-report item (i.e., Tybur et al., 2010) rather than political attitudes (i.e., Inbar et al., 2009) were removed, there was no evidence for moderation due to SC measures. Additionally, the removal of these studies also resulted in an I^2 and credibility interval, which both indicated a large increase in homogeneity in effect sizes ($I^2 = 28.84$;

[4] All publication bias analyses were conducted twice. Once using the corrected correlations and once using the uncorrected correlations. Only the figures from the analyses that used the corrected correlations are presented in this paper. The figures from the analyses that used uncorrected correlations can be obtained by contacting the corresponding author.

[5] The I^2 for psychometric meta-analysis is an adaption of Higgins I^2, which is based on the variance not attributable to sampling error. Because the Hunter and Schmidt (2004) psychometric meta-analysis approach corrects for measurement error, our adaption of the Higgins I^2 is based on the variance not attributable to sampling error and not attributable to differences across studies in measurement error. This adapted I^2, in common with the Higgins I^2, informs potential moderator analyses. The I^2 from the bare bones psychometric meta-analysis, in which no reliability corrections are made, is 66.35 which is nearly identical to the Higgins I^2. This is expected because neither analysis considers the variance associated with differences across studies in measurement error.

Table 3
Uncorrected and Corrected Effect Sizes, 95% Confidence Intervals, and Cronbach's αs for All Studies.

Study name	BIS measure	SC measure	Observed distribution[a]						Population distribution[b]		
			N	r	BIS α	SC α	Low 95% CI	High 95%CI	r[c]	Low 95% CI[c]	High 95% CI[c]
Terrizzi et al. (2010) Study 1	Disgust	RWA	146	0.49	0.89	0.95	0.36	0.60	0.53	0.35	0.68
Olatunji (2008)	Disgust	Religious	100	0.48	0.87[I]	0.93	0.31	0.62	0.53	0.30	0.71
Olatunji et al. (2005)	Disgust	Religious	100	0.45	0.86	0.95	0.28	0.59	0.50	0.27	0.68
Faulkner et al. (2004) Study 4	PVD	Ethnocentrism	47	0.40	0.83[I]	0.42[s]	0.13	0.62	0.68	−0.03	0.93
Hodson and Costello (2007)	PVD	RWA	103	0.39	0.88	0.87	0.21	0.54	0.45	0.22	0.63
Terrizzi et al. (2012) Study 1	Disgust	Religious	176	0.36	0.86	0.97	0.22	0.48	0.39	0.23	0.54
Clay et al. (in press) Study 2	PVD	Collectivism	263	0.33	0.77	0.68	0.22	0.43	0.46	0.29	0.60
Terrizzi et al. (2012) Study 2	Disgust	Religious	243	0.30	0.89	0.93	0.18	0.41	0.33	0.19	0.45
Navarrete and Fessler (2006) Study 1	PVD	Ethnocentrism	281	0.28	0.80	0.91	0.17	0.38	0.33	0.19	0.45
Duncan et al. (2009)	PVD	SDO	216	0.28	0.83	0.74	0.15	0.40	0.36	0.19	0.51
Terrizzi et al. (2010) Study 2	Disgust	RWA	99	0.25	0.68	0.95	0.06	0.43	0.31	0.07	0.52
Navarrete and Fessler (2006) Study 2	Disgust	Ethnocentrism	126	0.24	0.82	0.80	0.07	0.40	0.30	0.08	0.48
Inbar et al. (2009) Study 2	Disgust	Political	84	0.23	0.87[I]	0.80	0.02	0.42	0.28	0.02	0.50
Faulkner et al. (2004) Study 3	PVD	Ethnocentrism	86	0.22	0.83[I]	0.42[s]	0.01	0.41	0.37	0.00	0.66
Holtz et al. (2007)	Disgust	Collectivism	247	0.22	0.89[I]	0.68[I]	0.10	0.34	0.28	0.13	0.43
Inbar et al. (2012) Study 2	Disgust	Political	5457	0.22	0.86	0.64[s]	0.20	0.25	0.30	0.26	0.33
Faulkner et al. (2004) Study 2	PVD	Ethnocentrism	82	0.21	0.83[I]	0.42[s]	−0.01	0.41	0.36	−0.03	0.65
Clay et al. (in press) Study 1	Disgust	Collectivism	217	0.20	0.82	0.61	0.07	0.33	0.28	0.10	0.45
Inbar et al. (2012) Study 1	Disgust	Political	403	0.20	0.86	0.64[s]	0.10	0.29	0.27	0.14	0.39
Inbar et al. (2009) Study 1	Disgust	Political	181	0.20	0.87[I]	0.80	0.06	0.34	0.24	0.07	0.40
Tybur et al. (2010) Study 3	Disgust	RWA	375	0.19	0.77	0.93	0.09	0.29	0.23	0.11	0.33
Tybur et al. (2010) Study 2	Disgust	Political	253	0.06	0.87	0.88	−0.06	0.18	0.07	−0.06	0.20
Tybur et al. (2010) Study 1	Disgust	Political	363	0.03	0.83	0.64[s]	−0.07	0.13	0.04	−0.09	0.17
Smith et al. (2008)	Disgust	Political	51	0.02	0.86	0.73	−0.26	0.29	0.03	−0.30	0.34

CI = Confidence interval.
[a] Calculated in CMA using uncorrected correlations.
[b] Calculated in CMA using corrected correlations.
[c] Corrected for attenuation due to measurement error.
[I] Imputed from the measure's parent study.
[s] Single item alphas estimated using the Spearman-Brown Formula.

$CR_{.95}$ = .23, .46). Together, these results suggest that the relation between BIS and SC is substantially consistent across measures of SC.

Also, the meta-regression examining the effect of sex on the relation between BIS and SC was not significant for either the observed distribution (Q = 2.43, p > .05) or the estimated population distribution (Q = .79, p > .05). Thus, men and women did not differ in the strength of the association between BIS and SC.

3.3. Sensitivity analyses

The first sensitivity analysis, which examined whether the size of the effect varied by publication status, suggested that publication status did not moderate the association. The published studies reported a lower but not significantly different effect size than the unpublished studies (see Table 5).

The second sensitivity analysis used Duval and Tweedie's (2000) trim and fill technique. The resulting funnel-plot is presented in Fig. 1. When the corrected correlations were used, the results suggested that there were 8 studies missing from the analysis. The analysis indicated that when the studies were imputed the effect size was slightly lower (r = .25) compared to when they were not imputed (r = .31), suggesting that there may be some publication bias. When the uncorrected correlations were used, the analysis suggested that there are no studies missing and the mean effect size is .23.

Third, two cumulative meta-analyses were conducted in which studies were entered into the analysis based on their date of publication or precision. In the first cumulative meta-analysis, studies were entered based on their publication date (i.e., earliest studies entered first). The results suggested a time lag bias, which is indicative of some publication bias (see Fig. 2). In the second cumulative analysis, studies were entered based on their precision (i.e., most precise studies added first). The results of the analysis suggested a bias in which the most precise studies tend to have lower cumulative estimates. As one adds the less precise studies, the means drift higher suggesting that there is a bias such that the lower the precision, the higher the effect size. Together, these results indicate that there is a publication bias. The cumulative analyses in which the uncorrected correlates were used suggested that the true effect size is between .21 and .30. The analyses which used the corrected correlations suggested that the true effect size is between .26 and .36.

A final sensitivity analysis evaluated whether any one study had an inordinate effect on the estimate of the effect size. The results presented in Fig. 3 suggested that the summary effect size is a robust finding. The effect sizes with one study deleted were relatively homogenous ranging from .24 to .27 when the observed correlations were used and .30 to .33 when the corrected correlations were used.

Table 4
Summary Effect Sizes for All Models.

Model		Summary effect (r)	Low 95% CI	High 95% CI
Hedges and Olkin (1985)	Fixed Effects	0.23	0.21	0.25
	Random Effects	0.26	0.21	0.30
Hunter and Schmidt (2004)	Bare Bones	0.23	0.20	0.26
	Fully Corrected	0.30	0.26	0.34
Hybrid Analysis[H]	Fixed Effects	0.30	0.27	0.32
	Random Effects	0.31	0.26	0.36

CI = Confidence interval.
[H] Analysis performed in CMA with corrected effect sizes.

4. Discussion

The purpose of the current study was to provide a systematic review of the literature to evaluate the relation between the BIS and social conservatism. Across 24 studies, the findings suggest that there is a moderate, positive relation between BIS strength and social conservatism. Furthermore, the relation between BIS strength and SC

Table 5
Effect Sizes for BIS Measures.

Moderation	Measure/status	*k*	Observed distribution[a]				Population distribution[b]			
			Summary Effect (*r*)	Low 95% CI	High 95% CI	Q_{betwen}	Summary Effect (*r*)	Low 95% CI	High 95% CI	Q_{betwen}
BIS	PVD	6	0.29	0.23	0.35	4.34*	0.32	0.28	0.37	3.94*
	Disgust	18	0.25	0.19	0.30		0.30	0.24	0.36	
	Disgust (PC removed)	11	0.32	0.25	0.38	0.04	0.37	0.30	0.44	0.24
Social Conservatism	RWA	4	0.33	0.17	0.47	26.03**	0.34	0.22	0.45	14.14*
	SDO	1	0.28	0.15	0.40	6.67[P]	0.36	0.19	0.50	2.11[P]
	Religious	4	0.38	0.30	0.46	19.84[R]**	0.42	0.32	0.51	8.41[R]
	Ethnocentrism	5	0.26	0.19	0.34		0.34	0.23	0.43	
	Collectivism	3	0.25	0.17	0.33		0.34	0.22	0.45	
	Political	7	0.15	0.07	0.22		0.19	0.09	0.30	
	Scale/Social Conservatism	5	0.22	0.19	0.24		0.29	0.26	0.32	
	Unidimensional Measure	2	0.04	−0.04	0.12		0.06	−0.05	0.15	
Publication Status	Published	22	0.26	0.22	0.31		0.32	0.27	0.37	0.56
	Unpublished	2	0.16	−0.02	0.33		0.20	−0.04	0.42	

PC = Political conservatism.
CI = Confidence interval.
* $p<.05$.
** $p<.01$.
[a] Calculated in CMA using uncorrected correlations.
[b] Calculated in CMA using corrected correlations.
[P] With all PC studies removed.
[R] With the studies that measured PC using reported conservatism versus liberalism (i.e., Tybur et al., 2010) removed.

was not moderated by the type of BIS measure, i.e., the relation was consistent for both disgust sensitivity measures and PVD.

An initial analysis suggested that the relation between BIS and SC was moderated by SC measure. Measures of general conservatism (e.g., RWA, SDO, vertical collectivism) and religious conservatism appeared to be more strongly predicted by BIS strength than political conservatism. However, upon further analysis, it appears as though the studies that measured political conservatism using a unidimensional measure that does not distinguish social conservatism from economic conservatism (i.e., Tybur et al., 2010), had a significantly weaker relation with BIS strength compared to the studies that measured political conservatism using an attitudinal measure (i.e., Inbar et al., 2009). Once the two studies that used the unidimensional measure were removed, there was no evidence for moderation by SC measure, which suggests that BIS strength is consistently related to SC regardless of SC type. Thus, although Tybur et al. (2010) suggested that political conservatism is not a disease-avoidance strategy, the results reported in the current paper suggest that it is.

It is important to note, however, that it is not political conservatism in general but rather socially conservative political values which are associated with BIS strength (Terrizzi et al., 2010). The problem with unidemensional measures that ask participants to rate "how politically conservative they are" is that they do not allow researchers to disentangle socially conservative attitudes from economically conservative attitudes. In considering how the BIS might affect political conservatism, it is important to make the distinction between social and economic conservatism, as the BIS should influence social and not economic attitudes.

Together, these results support the thesis that social conservatism is in part an evolutionarily evoked disease-avoidance strategy. Interestingly, sex did not moderate the relation between BIS and SC. That is, men and women did not differ in the strength of association. This is not to say, however, that sex does not play an important role in the relation between BIS strength and social conservatism. It may be that BIS determines the strength of the magnitude of socially conservatism whereas sex determines the type.

Although the BIS literature is relatively young, cumulative meta-analyses suggest that there is some evidence of publication bias both in terms of precision and date of publication such that earlier studies slightly overestimate the magnitude of the effect. It is, however,

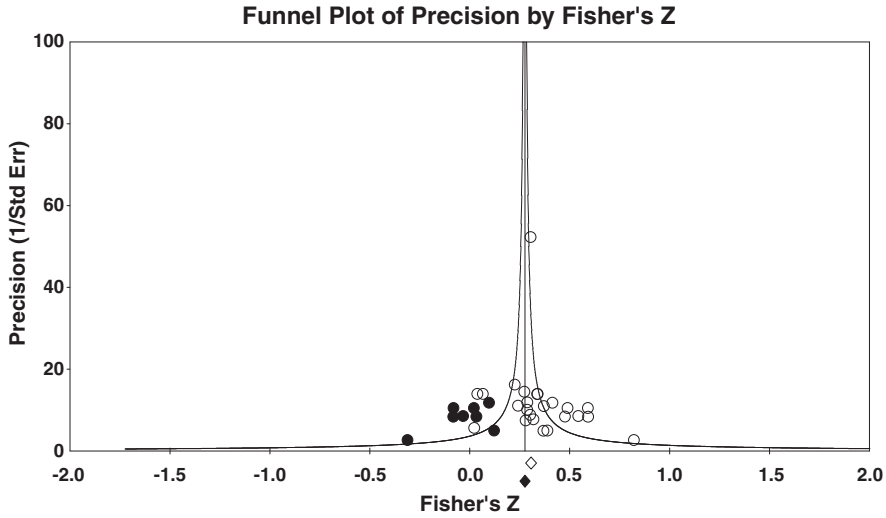

Fig. 1. Funnel plot (using corrected correlations) of precision by Fisher's Z with 8 studies imputed.

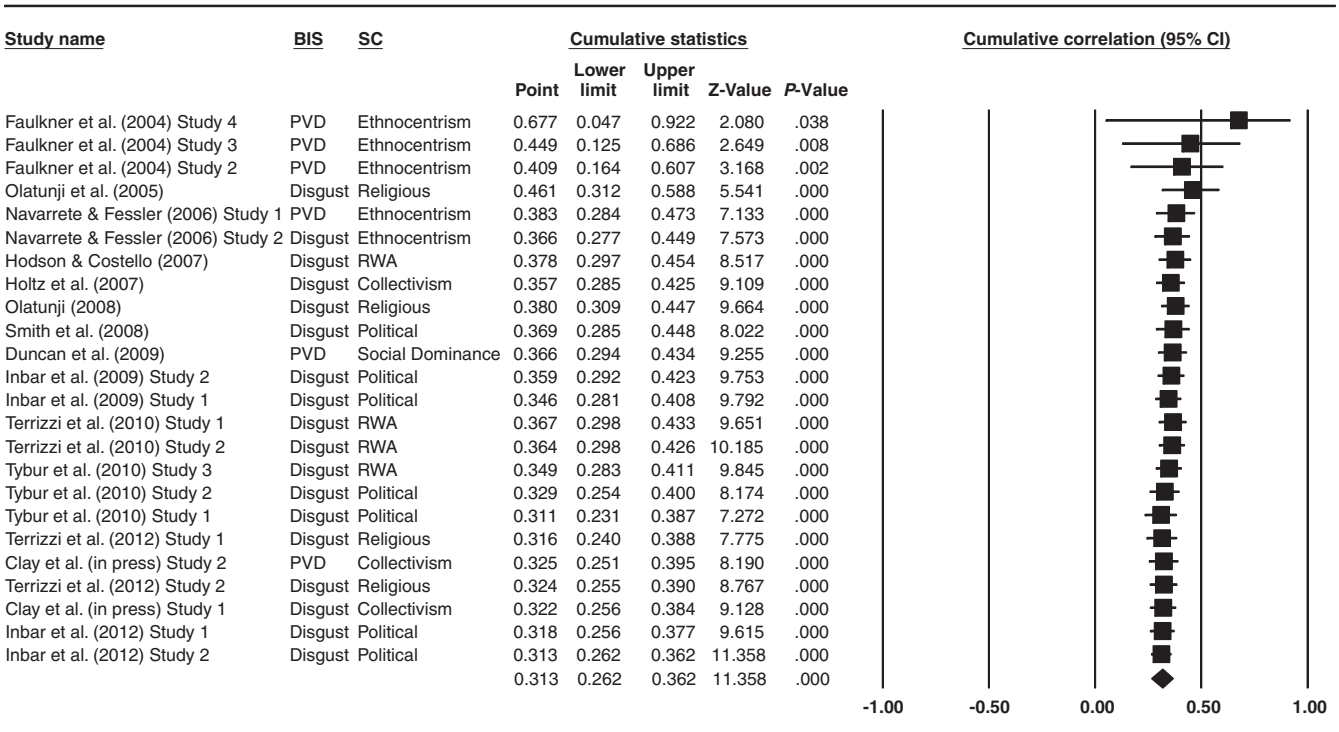

Fig. 2. Cummulative meta-analysis (using corrected correlations): Studies entered based on publication date.

important to note that although the publication bias does not allow for a precise estimate of the true effect, the effect is still significant and in the predicted direction. In order to obtain a more accurate estimate of the true effect size, more studies need to be conducted examining each of the different types of social conservatism (e.g., religious conservatism, political conservatism). Additionally, some of the studies in the current meta-analysis (e.g., Faulkner et al., 2004; Tybur et al., 2010) used single indicators of social conservatism and some studies (e.g., Faulkner et al., 2004; Smith et al., 2008) used small sample sizes (~50). Future research should incorporate more reliable measures and larger sample sizes in order to obtain more precise estimates of the effect.

The purpose of the current meta-analysis was to investigate whether social conservatism is in part an evolutionarily evoked

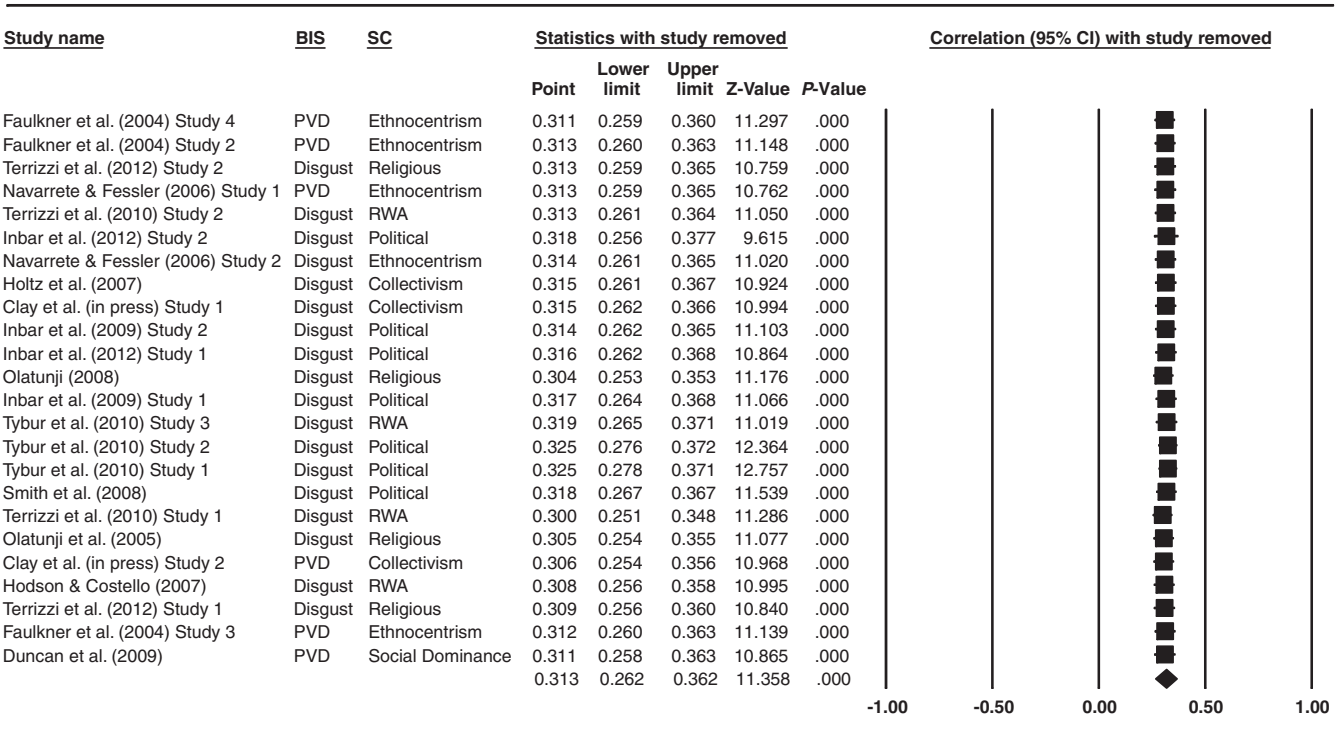

Fig. 3. Sensitivity analysis (using corrected correlations): effect sizes with one study removed.

disease-avoidance strategy. However, threat of contamination is not the only reason that people adopt socially conservative value systems. Historically, outgroup members were not only dangerous because they carried diseases and parasites, they also posed a threat in terms of predation and competition for limited resources. It is likely that humans have evolved domain specific mechanisms that provide different solutions for the varied threats that outgroups pose (see Neuberg, Kenrick, & Schaller, 2011). For example, disgust may provide a solution to the threat of infectious disease whereas anger may provide a solution to outgroup violence. Thus, it is reasonable to assume that different types of perceived threat may elicit different forms of social conservatism. In fact, some recent evidence suggests that although RWA and SDO both encourage prejudice toward outgroup members, they operate differently in that RWA is predictive of negative attitudes toward outgroups who pose a social threat and SDO is predictive of negative attitudes toward economically disadvantaged groups (Duckitt & Sibley, 2010). Additionally, beyond protecting individuals from potential outgroup threats (e.g., predation, disease threat, competition for resources), social conservatism may have developed as a means of encouraging ingroup cohesion and group functioning, as well as deterring defection of ingroup members.

The results of the meta-analysis provide some initial evidence that the BIS is predictive of social conservatism. If the BIS functions as a system of evolved disease avoidance mechanisms and other people were a historically significant source of contamination, it stands to reason that the BIS should influence social behavior and intergroup interactions. Although the data that were analyzed in the current meta-analysis are correlational and do not allow for a causal explanation, theoretically, these data support a model in which the BIS may lead to the adoption of socially conservative value systems which function as a means of encouraging outgroup prejudice and avoidance. Recent work has supported this causal sequence (Terrizzi et al., 2012). Also, some research indicates that historical rates of disease prevalence are predictive of social conformity (e.g., collectivism; Murray, Trudeau, & Schaller, 2011; Fincher et al., 2008), and that this relation is partially mediated by genetic variation (Chiao & Blizinsky, 2010).[6] Thus, the BIS may regulate social relationships by fostering value systems that protect individuals from outgroup members who may pose a disease-threat.

4.1. Limitations

Although the current meta-analysis provides evidence for a robust relation between the BIS and social conservatism, there were some limitations. First, only correlational studies were included in the meta-analysis. Although there are studies that have demonstrated that the activation of the BIS leads to increased prejudice toward outgroups, the current evidence cannot be interpreted as a causal relationship. As of yet, there have not been any studies examining whether activation of the BIS affects social conservatism. One of the recommendations from the current study is that future research focus on experimental methods that examine whether BIS activation increases social conservatism. As studies accumulate, a meta-analysis should be conducted on the experimental research in order to conclusively demonstrate the causal relationship between the BIS and social conservatism.

A second limitation is the small number of studies examining the relation between the BIS and social conservatism. This is a burgeoning area of research and the current meta-analysis should encourage researchers to conduct more studies to examine the relation between the BIS and social conservatism. Additional studies are needed in order to determine how far the current results generalize. Future research should focus on alternative indicators of social conservatism including indicators of social network size (e.g., number of friends) and diversity (e.g., number of groups). Lastly, this study used a broad definition of social conservatism. Although the results indicate that the relationship between the BIS and social conservatism is relatively robust across measures of BIS and social conservatism, more studies need to be conducted to determine whether there is any moderation.

Finally, it is important to highlight the fact that individual difference in BIS strength only account for as much as 9% of the variability in social conservatism. Although the effect is discussed in terms of individual differences, it may be that the effect could be explained in terms of contextual effects (e.g., order effects). However, it is important to remember that the current meta-analysis analyzed the effect across 24 studies in which varying methods and measures were used. Given that the effect is relatively consistent across studies, it is unlikely that the effect is a contextual artifact. An alternative explanation of the moderate effect size could be the fact that the measures that were used are only crude indicators of social conservatism. Future studies should explore the relationship between BIS and social conservatism by using measures of social conservatism that assess ingroup size (e.g., number of friends) and homogeneity (e.g., shared characteristics). Lastly, disease-threat is not the only problem posed by outgroup members. They also pose threats of violence and resource allocation. Thus, the BIS should not be expected to account for all of the variability in social conservatism.

4.2. Conclusion

The BIS is described as a cluster of psychological mechanisms that encourage prophylactic behavior (Schaller, 2006). Outgroup members are a possible source of contamination. Consistently, BIS activation has been shown to increase prejudice toward outgroup members (Faulkner et al., 2004; Navarrete & Fessler, 2006; Schaller & Duncan, 2007). The current research extends these findings by demonstrating that the BIS is predictive of social conservatism. These findings provide initial evidence that the BIS (e.g., PVD and disgust) functions as a disease-avoidance system that may encourage socially conservative value systems (e.g. RWA, SDO, and religious conservatism). Accordingly, socially conservative value systems may function in part as evolutionarily evoked disease-avoidance strategies.

[6] Chiao and Blizinsky (2010) have been criticized for failing to consider a null model for their findings (see Eisenberg & Hayes, 2011).

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