




‘Look not at what is contrary to propriety’: A meta-analytic exploration of the association between religiosity and sensitivity to disgust

Zhaoliang Yu¹, Persefoni Bali², Myron Tsikandilakis^{2,3*}  and
Eddie M. W. Tong¹

¹Department of Psychology, National University of Singapore, Singapore

²School of Psychology, University of Nottingham, UK

³Faculty of Medicine and Health Sciences, Medical School, University of Nottingham, UK

Previous research has suggested that disgust sensitivity contributes to moral self-regulation. The relationship between religiosity and disgust sensitivity is frequently explored as a moderator of moral-regulating ideologies, such as conservative and traditional ideologies. However, religiosity is suggested to differ from these in moral attitudes against social dominance and racial prejudice. Psychological theories, such as the societal moral intuition and the evolved hazard-perception models, have proposed that there could be reasons to support a distinct relationship between religiosity and disgust sensitivity. These reasons relate to the intuitive pursuit of spiritual purity and the non-secular transcendental emotional-reward value of moral behaviour for religious individuals. In the present manuscript, we conducted the first dedicated meta-analytic review between religiosity and disgust sensitivity. We analysed a summary of forty-seven experimental outcomes, including 48,971 participants. Our analysis revealed a significant positive association ($r = .25$) between religiosity and disgust sensitivity. This outcome suggests that sensitivity to disgust could have distinct spiritual purity and moral self-regulatory response value for religious individuals.

Research associated with disgust sensitivity has progressed substantially in the past two decades. Despite the increasing empirical engagement in research relating to disgust sensitivity, the distinction between disgust and disgust sensitivity is frequently not addressed in relevant research (see Herz, 2012). For example, disgust, as an emotion, has been suggested as having an adaptive psychological function for responses to environmental adversity, such as contributing to avoidance responses to pathogen and contamination-related cues, and conferring self-regulation inhibitory responses to distressing emotional elicitors (Curtis, de Barra, & Aunger, 2011). It relates to physiological (Stark, Walter, Schienle, & Vaitl, 2005), neural (Wicker et al., 2003; but

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*Correspondence should be addressed to Myron Tsikandilakis, School of Medicine, Faculty of Medical and Health Sciences, School of Psychology, University of Nottingham, University Park Campus, Psychology, Pharmacy, Life Sciences, East Dr, Nottingham NG7 2RD, UK (email: tsikandilakismyron@gmail.com; Tsikandilakis.myron3@nottingham.ac.uk).

see also Schienle et al., 2002), and behavioural reactions (Curtis et al., 2011) to physically and/or emotionally aversive pathogenically harmful and contagious environmental elicitors (see Miller, 2013). On the other hand, disgust sensitivity is commonly measured using questionnaire and scale assessment items (see Olatunji et al., 2007). It often refers to the belief or self-report that certain events, behaviours, or elicitors and cues are aversive (Olatunji & Broman-Fulks, 2007). Disgust sensitivity can refer to the belief that a person will experience certain stimuli as aversive (Jones & Fitness, 2008), without necessarily measuring, and therefore, arguably (Reisenzein, 2009), directly assessing a person's reactivity to stimulus exposure (see, for example, DeBruine, Jones, Tybur, Lieberman, & Griskevicius, 2010).

Religiosity has been defined as an affiliation with a system or doctrine that includes beliefs and a moral code related typically to a non-human spiritual or transcendental entity, or entities (Shariff, 2015). As such, it involves practices and beliefs that are suggested to have distinctive evolutionary origins and trajectories to secular systems (Barrett, 2000). Existing psychological models suggest that religiosity should be positively associated with sensitivity to disgust. For example, the societal moral intuition model (Baumard & Boyer, 2013) proposes that divine beings monitor believers to ensure that they behave in line with religious moral rules (Maclean, Walker, & Matsuba, 2004). This monitoring ensures that good deeds are rewarded, and bad deeds are punished (see Baumard, Hyafil, Morris, & Boyer, 2015; Boyer, 2002; Boyer & Bergstrom, 2008). The sense of being monitored proposedly prompts religious individuals to abstain from behaviours and cognitions that impact spiritual purity. Therefore, religiosity could uniquely correlate with sensitivity to disgust as a protective and self-regulatory experience (Shariff, 2015). Another psychological model that supports a unique relationship between religiosity and disgust sensitivity is the theory of the Evolved Hazard-Precaution System (EH-PS; Boyer & Liénard, 2006). The EH-PS suggests that human beings possess an evolved system that regulates behaviours to potential environmental contamination (Boyer & Liénard, 2006; Liddell et al., 2005). This system has been argued to have evolved to contemporary religious laws relating to purity and moral behaviour (Barrett, 2000; Baumard & Boyer, 2013; van Leeuwen, Dukes, Tybur, & Park, 2017; Shariff, 2015).

Past empirical research has often, and possibly erroneously, examined how religiosity relates to disgust sensitivity, as an indistinct manifestation, aspect, or subcategory of conservative and traditionalist ideologies (see Modood, 2010). Contemporary psychological theory and research have addressed religiosity as interchangeable forms of conservatism, which typically includes right-wing authoritarianism and social-dominance orientations (see, for example, Terrizzi, Shook, & McDaniel, 2013, pp. 100–101). This is possibly a misconception. Firstly, religiosity correlates only weakly with social-dominance orientations, such as the imposition of ideology-related secular laws, which is one of the major dimensions of political belief and right-wing authoritarianism in particular (e.g., Sibley, Robertson, & Wilson, 2006). Secondly, previous research has also shown that after controlling for authoritarianism, even extreme aspects of religiosity, such as religious fundamentalism, negatively predict racial prejudice, suggesting that religiosity could include components beyond and above social and political traditionalism (Laythe, Finkel, & Kirkpatrick, 2001).

As proof of concept of the possibly erroneous indissociable association of religiosity, traditionalism, and conservatism, previous meta-analytic research has examined the relationship of religiosity and sensitivity to disgust either as a moderator or as a minor part of wider correlation analyses with political-oriented primary research objectives. These meta-analytic attempts assessed the relationship between disgust sensitivity, and

conservative and traditional ideologies (Beit-Hallahmi, 2014). Two partially relevant reviews are available in this area. These examined the correlation between the behavioural immune system and social conservatism (see Terrizzi et al., 2013), and parasite stress and pathogen avoidance, and political beliefs (Tybur et al., 2016). In the latter, conservatism is included as a subset of political belief and religiosity as a moderator for conservatism. The analysis does not include a correlation coefficient or further insight concerning religiosity and its relation to parasite stress and pathogen avoidance (Tybur et al., 2016, pp. 12410–12411).¹ In the former, religiosity is included as a subset of social conservatism (Terrizzi et al., 2013, p. 100). The researchers report a significant correlation coefficient ($r = .38$) between religiosity and behavioural immune system responses in a small heterogeneous and statistically uncorrected for heterogeneity, funnel plot asymmetry, and publication bias subsample of the overall analysis ($k = 4$; $Q = 18.84$; $p < .01$; Terrizzi et al., 2013, p. 105).

Religiosity has not been sufficiently addressed in relation to disgust sensitivity in previous meta-analyses and the variables that could moderate this association also remain unexplored. Religiosity has been found to predict numerous important outcomes, including strengthened emotional and moral self-regulatory abilities (Fincher & Thornhill, 2012; McCullough & Willoughby, 2009; Sedikides & Gebauer, 2010). Religiosity has also been found to be negatively associated with substance use and criminal behaviour in adolescents (Baier & Wright, 2001; Yeung, Chan, & Lee, 2009). These findings suggest that disgust sensitivity to aversive and deviancy-related cues could be a regulatory mechanism that contributes to self-control in religious individuals. Disgust sensitivity has been suggested to reflect beliefs that relate to adaptive significance, manifested by their effectiveness in various processes, such as pathogen avoidance, regulating mating decisions and moral judgement processes, corresponding respectively to pathogen, sexual, and moral subtypes of disgust sensitivity (Ekman, 1992; Tybur, Lieberman, Kurzban, & DeScioli, 2013). This suggests that trait-level sensitivity to disgust could reflect beliefs in behaviours and responses that have a protective role to socio-biological elicitors that result in moral-behavioural transgression (Rozin & Haidt, 2013).

Previous research has suggested that both disgust sensitivity and religiosity predict moral condemnation of purity-based transgressions (Preston & Ritter, 2012). They have also been related to ingroup sociality, and preferred outgroup contact with individuals that uphold values relating to spiritual and personal harmony (Fincher & Thornhill, 2012; Saroglou, Delpierre, & Dernelle, 2004). Previous research has suggested that religiosity and sensitivity to disgust could partake in several other – less obvious – interactions. For example, a more exploratory hypothesis stemming from previous findings is whether factors such as age, gender, and sample type, that have been shown to separately impact religiosity and sensitivity to disgust, will influence a possible association (Fincher & Thornhill, 2012; Tybur et al., 2013).

Previous research has provided evidence that religiosity is positively associated with responses in questionnaire assessments that include sexual inhibition, fear of pathogens, and purity-based moral judgements (McCullough & Willoughby, 2009; Wagemans, Brandt, & Zeelenberg, 2018). Interestingly, these factors comprise three basic subtypes of disgust sensitivity (i.e., sensitivity to pathogen, sexual, and moral disgust), suggesting that disgust sensitivity subtypes could be associated with religiosity (Curtis et al., 2011; but see

¹ This information is also not available in the online supplementary material that the authors provide (Tybur et al., 2016, p. 12408).

also Kriegeskorte, Simmons, Bellgowan, & Baker, 2009). Previous literature has provided support for these propositions. For example, the evolutionary costly-signalling theory (Sosis, 2003; Sosis & Bressler, 2003) suggests that religious participation incurs costs of resources and opportunities to believers, which in turn could signal their allegiance to their religious group. Fincher and Thornhill (2012) argued that this allegiance could reduce one's exposure to infectious diseases through evolved emotional defensive mechanisms of sensitivity to contamination and disgust. Hence, it is reasonable to predict that religiosity should be positively associated with pathogen disgust sensitivity. Previous researchers have also suggested that religiosity could predict greater sensitivity to sexual disgust. Religious participation enables the inclination of fitness-enhancing values that preserve social orders (Maclean et al., 2004; Saroglou et al., 2004), including the regulation of one's sexuality. Relatedly, moral disgust has been suggested to relate to sacred, purity-based values that largely overlap with religious moral codes (Rozin & Haidt, 2013; Rozin, Haidt & McCauley, 2008; Wagemans et al., 2018). These provide theoretical and empirical support that positive correlational relationships could also be revealed between religiosity and sensitivity to disgust subtypes, including pathogen, sexual, and moral disgust.

Echoing the need for a distinct exploration of religiosity and sensitivity to disgust (see, Slone, 2016), in the present research, we undertook a meta-analysis to explore the relationship between religiosity and sensitivity to disgust. We rigorously assessed, using state-of-the-art statistical methods, a thoroughly controlled summary of forty-seven experimental outcomes including 48,971 participants on the relationship between religiosity and disgust sensitivity. We explored the association between religiosity and disgust sensitivity subtypes, such as pathogen and sexual disgust sensitivity.² We also explored the effect of variance-moderating variables in these associations, such as gender, age, and sample type (university student and general population). Finally, we presented our end results in a complete, comprehensive, and interactive meta-analysis matrix with statistical outcomes for each included variable.

Methods

We conducted a literature search in February 2020 in Ovid (including the databases of PsycINFO and PsycARTICLES), PubMed, Web of Science, and Google Scholar, using the syntax *religio** (or *faith**) and *disgust** and the abbreviations of disgust sensitivity and religiosity scales (e.g., *DS-R*, *TDDS*, and *SRR*; see Figure 1). We also hand-searched the reference list of each relevant paper and the publication history of each included author. An email requesting published and unpublished data was sent to researchers who had published studies that related to the current theme. A call for data was also advertised in relevant data repositories, such as the Open Science Framework, Academia.edu, ResearchGate, and the Society for Personality and Social Psychology (SPSP) Open Forum (see Figure 1 for a detailed searching strategy). The inclusion criterion for the current meta-analysis was the assessment in the same study of both religiosity and disgust sensitivity as continuous or categorical variables. Studies that assessed clinical populations were excluded from the analysis. The study selection was done by four researchers and cross-checked between them. Thirty-seven articles including twenty-six published

² Our literature search revealed very limited data for moral sensitivity to disgust data ($k = 3$; $n < 100$) that did not fit the minimal criteria for meta-analytic research (see Borenstein, Higgins, Hedges & Rothstein, 2017; Hedges & Schauer, 2019).

journal articles, two PhD theses, two MA theses, one journal article currently under review, and six unpublished datasets were included in the final sample that consisted of forty-seven experimental outcomes and a total of 48,971 participants (26,297 female). In all studies, disgust sensitivity was consistently measured as a continuous, interval, or ratio variable, using personality questionnaires, Likert scale responses, and questionnaire response assessments to disgust-related stimuli, such as aversive, immoral, and taboo items (Tybur et al., 2013). Religiosity was measured either as a continuous or as a categorical variable using personality assessments, categorical responses for religious affiliation, or responses to religious-related elicitors (Gervais, Shariff, & Norenzayan, 2011). When religiosity was measured continuously, the reported Pearson's r for the primary analysis was used. When religiosity was measured dichotomously (e.g., 'Yes' or 'No'), the statistical outcome was converted from Cohen's d to Pearson's r according to the formulas provided by Borenstein, Higgins, Hedges, and Rothstein (2017, pp. 47–48; see also Table 1): $r = \frac{d}{\sqrt{(d^2 + \alpha)}}$, where α is a correction of variance for unequal population

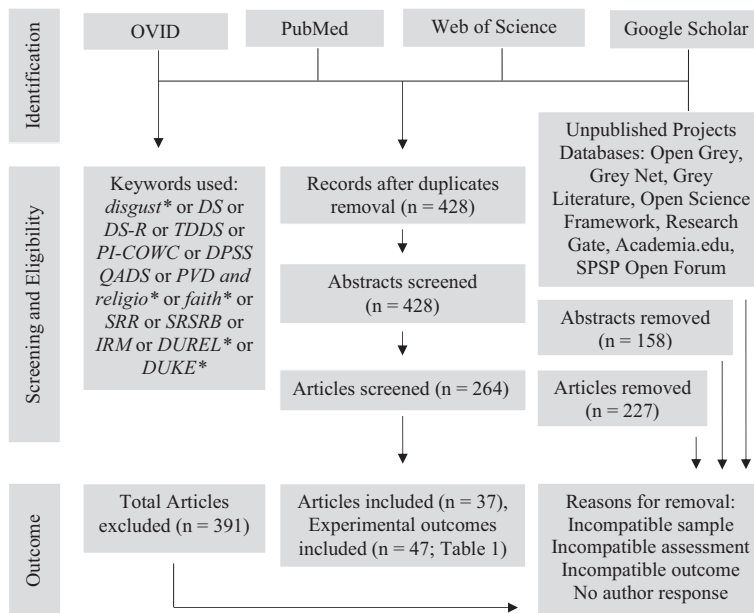


Figure 1. Systematic review and literature search matrix. Schematic representation of the systematic review and literature search for religiosity and sensitivity to disgust. Published articles databases and unpublished articles databases were used. The PubMed, Web of Science, and Google Scholar searches were refined for empirical research papers, conferences, and indexed and non-indexed articles in all available research domains. The Ovid search included PsycARTICLES, PsycINFO, EMBASE, OVIDMEDLINE (R), and OVIDMEDLINE (R) *ahead of print, non-indexed, and in-process* articles (1946 to present). The key words were kept consistent using advanced search *and/or* commands, and they were designed to include keyword stems, and sensitivity to disgust and religiosity assessment indexes. All the unpublished datasets included in the analysis ($n = 6$; see Table 1) were provided directly by the authors in raw data format after posting a data request concerning the current meta-analysis in several subject compatible science forums (SPSP Open Forum, Academia.edu, Research Gate, etc.). The meta-analytic bibliography and data are included in Supplementary Materials.

Table 1. Included studies

Authors	Sample size (n)	Country	Type of sample	Mean age (SD)	Gender (female)	Religiosity measure(s) ^a	Disgust sensitivity measure(s) ^b
Alcan (2015; MA Thesis)	254 ^c	Turkey	Students	22.9 (3.22)	171	Religious affiliation, MFQ, Self-developed (Likert scale)	LODQ, PI-COWC, DS-R, CCS
Berger & Anaki (2014a)	1427	Israel	General	33.18 (12.6)	767 (◆) ^d	Self-developed (categorical scale)*	DSS-R
Berger & Anaki (2014b)	321 ^e	Israel	General	33.7 (12.7)	168 (◆)	Self-developed (Likert scale)	DS-R
Clay, Terrizzi Jr., & Shook (2012), Study 2	303 ^f	USA	Students	26.17 (◆) ^g	209 (◆)	Schwartz value Scale (T/C)	DS-R, DPSS, PVD, PI-COWC
Crawford, Inbar, & Maloney (2014)	236	USA	General (MTurk)	37 (■)	127 (◆)	Religious affiliation*	DS-R
Feinberg, Antonenko, Willer, Horberg, & John (2014), Study 1a	125	USA	General (MTurk)	27.28 (■)	70 (◆)	Self-developed (Likert scale)	DS-R
Fergus & Rowatt (2017)	320	USA	Students	19.1 (1.2)	231 (◆)	Religious affiliation, GRS	DPSS-R, MCR
Gervais et al. (2011), Study 1	351	USA	General (www.zoomerang.com)	43.9 (14.33) (◆)	207 (◆)	Religious affiliation, Disgust Thermometer: Self-developed (Likert scale), Self-developed binary scale (Y/N)*	Self-developed Continuous scale (0-100)
Haidt, McCauley, & Rozin (1994), Sample 1	182	USA	Students	19 (■)	111 (◆)	Strength of Belief: Self-developed (Likert scale)	DS

Continued

Table 1. (Continued)

Authors	Sample size (n)	Country	Type of sample	Mean age (SD)	Gender (female)	Religiosity measure(s) ^a	Disgust sensitivity measure(s) ^b
Haidt, McCauley, & Rozin (1994), Sample 2	126	USA	Students	19 (■)	68 (◆)	Strength of Belief: Self-developed (Likert scale)	DS
Haidt, McCauley, & Rozin (1994), Sample 3	170	USA	General	40 (■)	61 (◆)	Strength of Belief: Self-developed (Likert scale)	DS
Haidt, McCauley, & Rozin (1994), Sample 4	46	USA	General	36 (■)	18 (◆)	Strength of Belief: Self-developed (Likert scale)	DS
Hendrick & Hall (2019; unpublished data)	249	USA	General (MTurk Prime)	34.6 (10.15)	73	Central Religiosity Scale	Self-developed Disgust Assessment Likert Scale)
Inbar, Pizzaro & Bloom (2009), Study 1	178 ^h	USA	General (www.zoomerang.com)	■	99	Religious affiliation*	DS-Short
Inbar, Pizzaro, Iyer, & Haidt (2012), Study 1	25588	USA	General (YourMorals.org)	40 (■)	13024 (◆)	Religious affiliation, frequency of religious attendance	DS-R
Inozu, Ulukut, Ergun, & Alcolado (2014)	244	Turkey	Students	20.62 (1.97)	184	Religious affiliation, Religious Commitment and Salience scale: self-developed (Likert scale)	DS-R
Inozu, Eremsoy, Cicek, & Ozcanli (2017)	64 ⁱ	Turkey	Students	21.73 (3.24)	43	Religious affiliation, self-developed (Likert scale), PIOS	DS-R, PI-COWC, CCS
Kapitan & Bhargave (2013), Study 1B, D ^j	150	USA	General (MTurk)	36.9 (■)	87 (◆)	Self-developed (Likert scale)	DS, PVD

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Table 1. (Continued)

Authors	Sample size (n)	Country	Type of sample	Mean age (SD)	Gender (female)	Religiosity measure(s) ^a	Disgust sensitivity measure(s) ^b
Kollareth & Rusell (2019), Study 2	240	USA	General (MTurk)	33.39 (◆)	118 (◆)	Religious affiliation, Self-developed (Likert scale)	Self-developed (Likert scale)
Lorona & Fergus (2017)	146	USA	Students	19.21 (1.25)	47 (◆)	GRS	DPSS-R
Nelissen, Dijker, & de Vries (2007)	487	Netherlands	Students	21 (■)	438	Schwartz Value Scale	Izard, Libero, Putman & Haynes (1993): Emotion Scale (◆)
Olatunji, Tolin, Huppert, & Lohr (2005) ^k	100	USA	Students	22.6 (4.94)	57	PIOS	DS-R (adapted)
Ottaviani, Mancini, Petrocchi, Medea & Couyoumdjian (2013)	40	Italy	Students	28.75 (5.45) (◆)	20	PVQ Tradition, Self-developed binary scale (Y/N), Self-developed Religious Attendance Scale (not used)	DS-R
Oum (2010; PhD Thesis)	98	USA	Students	18.7 (1.3)	70	RCS, RFS, RCI-10	TDDS
Piazza & Sousa (2014) Study 1	349	USA	General (MTurk)	29.92 (11.66)	141	Self-developed (Likert scale)	DS-TDDS (adapted index), Self-developed: Transgression Scale (Likert scale)

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Table 1. (Continued)

Authors	Sample size (n)	Country	Type of sample	Mean age (SD)	Gender (female)	Religiosity measure(s) ^a	Disgust sensitivity measure(s) ^b
Piazza & Sousa (2014) Study 2	147	USA	General (MTurk)	34.67 (13.73)	67	Santa Clara Strength of Religious Faith Questionnaire	DS-TDDS (adapted index), Self-developed;
Piazza & Sousa (2014), Study 3	192	USA (n = 104) (◆) India (n = 88) (◆) USA	General (MTurk)	31.92 (11.32)	75	Self-developed (Likert scale)	Transgression Scale (Likert scale)
Ritter and Preston (2011; Published MA Thesis) Experiment 1	82	USA	Students	19 (■)	53	Religious affiliation (Christian participants ^{††})	Self-developed disgust scale (Likert Scale)
Ritter (2014; Published PhD thesis), Experiment 1	266	USA	General (MTurk)	32.24 (11.5)	115	Religious affiliation, Self-developed: Four-item religiosity measure (Likert scale)	Self-developed: Basic Emotion Scale (Likert scale)
Ritter, Preston, Salomon & Relihan-Johnson (2015), Study 1b	281	USA	General (MTurk)	33.62 (12.41)	122	Religious Affiliation, Self-developed: Four-Item Religiosity Measure (Likert Scale)	Basic Emotion Scale (Likert Scale)
Rottman, Kelemen & Young (2014), Study 1	174	USA	General (MTurk)	21.14 (13.96)	114	MFQ, Religious affiliation, Self-developed: Belief scale (Likert scale)	DS-Short, Self-developed: Disgust measure (Likert scale)

Continued

Table 1. (Continued)

Authors	Sample size (n)	Country	Type of sample	Mean age (SD)	Gender (female)	Religiosity measure(s) ^a	Disgust sensitivity measure(s) ^b
Ruisch, Anderson, Inbar & Pizzaro (2019; under review)	480 ⁿ	USA	Mixed (Students and General Public)	22.19 (■)	288	Self-developed: Religiosity Self-Assessment Scale (Likert scale)	DS-R
Ruisch, Rajen, Anderson, Inbar & Pizzaro (2016a; unpublished data)	302	USA	General (MTurk)	35.27 (■)	133	Self-developed: Religiosity Self-Assessment Scale (Likert scale)	DS-R
Ruisch, Rajen, Anderson, Inbar & Pizzaro (2016b; unpublished data)	627	USA	General (MTurk)	37.99 (■)	370	Self-developed: Religiosity Self-Assessment Scale (Likert scale)	DS-R
Saroglou & Ancliaux (2004)	256	Belgium	General	46.1 (24.3)	124 (◆)	COPE, Self-developed (two-item Likert scale)	Self-developed: Response to sick humour (Likert scale)
Sheikh, Ginges, Coman, & Atran (2012), Study 1	334	USA	General (Craigslist)	42 (3.06)	164 ^o (◆)	Berns, Bell, Capra, Prietula et al. (2012), Measure for Sacred Values (◆) SV, self-developed religiosity scale (Likert scale)	DS-R
Skolnick & Dzokoto (2013), Sample 1	101	Ghana	Students	25.3 (4.50)	57	Cohen, Malika, Rozin & Cherfas (2005): Religiosity Scale (◆)	DS-R, TDDS, PI-COWC, PVD

Continued

Table 1. (Continued)

Authors	Sample size (n)	Country	Type of sample	Mean age (SD)	Gender (female)	Religiosity measure(s) ^a	Disgust sensitivity measure(s) ^b
Skolnick & Dzoakoto (2013), Sample 2	96	USA	Students	19.6 (1.10) ^p	58	Cohen, Malika, Rozin & Chertfas (2005): Religiosity Scale (◆)	DS-R, TDDS, PI-COWC, PVD
Terrizzi, Clay, & Shook (2014), Study 3	146	USA	First-year Psychology Students	18.84 (2.46)	99 (◆)	RFS	DS
Terrizzi, Clay, & Shook (2014), Study 4	279	USA	First-year Psychology Students	19.73 (3.69)	206 (◆)	RFS	DS, TDDS, PI-COWC
Terrizzi, Shook, & Ventis (2012), Study 1	176	USA	First-year Psychology Students	18.83 (1.17)	92 (◆)	RLI PCBS	DS, TDDS
Terrizzi, Shook, & Ventis (2012), Study 2	300	USA	First-year Psychology Students	19.66 (3.59)	222 (◆)	Religious affiliation, self-developed (Likert scale), RFS	DS, TDDS, PI-COWC
Trapnell & Buckels (2006; unpublished data)	746	Canada	Students	19.86 (4.6)	224	Religious affiliation, Self-Developed: Religious Self-Categorization (Three Stages Likert Scale)	DS-R (25 Items Scale)
Tybur et al. (2016)	11501	30 nations	General	30.06 (12.62)	6671 (◆)	Religious Attendance	TDDS
Tybur, Inbar, Güler, & Molho (2015), Study 2	238	USA	General (MTurk)	32.75 (11)	100	Pew Research Survey: Self-developed binary scale (Y/N) [*]	TDDS, DS-R
Tybur, Merriman, Hooper, McDonald, & Navarrete (2010), Study 3	475	USA	Students	19.9 (■)	322	RFS	TDDS

Continued

Table 1. (Continued)

Authors	Sample size (n)	Country	Type of sample	Mean age (SD)	Gender (female)	Religiosity measure(s) ^a	Disgust sensitivity measure(s) ^b
Yeiderman, Haggard, Olsen, Ahmadi, Knighten & Rowatt (2012; unpublished data)	126	USA	Students	18.78 (.73)	99	Religious Affiliation, Self-developed: <i>Religious Interest and self-assessment</i> (Three Stages Likert Scale), Quest Scale, RFS-R (12 Item Scale)	DS-R, TDDS, PVD

Demographics for the final subset of studies included in the meta-analysis. Separate studies from the same article were included when the population sample (n) was reported as different between different stages to avoid resampling meta-statistical data (Felson, 1992). No instances of recurrent population samples or participants were reported to necessitate the implementation of a study selection process. No instances of recurrent population samples or participants were reported to necessitate the implementation of a study selection process. *Italics* are used to describe the name of self-developed scales when these were assigned specific title names within each article. * (Asterisk) in the Religiosity Measures column signifies effect-size conversions (Borenstein et al., 2017, pp. 47–48). The data provided by the included studies referred to an aggregate score of the included religiosity and disgust sensitivity measures. Further information in paper, in online repositories, and from individual authors.

^aFor a review on religiosity assessments, see Hood, Hill, and Spilka (2018); ^bFor a review on sensitivity to disgust assessments, see Tybur and Karinen (2018); ^cSample is described as $n = 255$ in certain parts of the *Participants* section (p. 40) and as $n = 254$ in other parts of the *Participants* (p. 40), *Methods* (p. 41), and *Results* sections (p. 52). The sample size for this study was calculated from the degrees of freedom as reported in the analysis ($n = 254$, p. 52); ^dThe symbol “♦” indicates that the paper did not include this information but included sufficient additional information for providing or calculating it (see Supplemental Material: Mathematical Coding and Computations); ^eThe *Abstract* and the *Participants* sections (p. 250) indicate $n = 314$. The *Results* section (p. 251) and Table 3 (p. 252) indicate $n = 321$. The sample size for this study was calculated from the degrees of freedom as reported in the analysis ($n = 321$, pp. 251–252); ^fOriginal sample $n = 327$ (p. 179); after participant exclusion, $n = 303$ (p. 182); ^gThe symbol ‘■’ indicates that the manuscript did not include this information or sufficient information for calculating it and that the current authors were not able to retrieve this information via correspondence with the researchers (see Supplemental Material: Mathematical Coding and Computations); ^h*Abstract* and *Participants* sections indicate $n = 181$. Three participants were excluded because they were religious minorities (p. 5; footnote 1) resulting in $n = 178$; ⁱThe original sample included 209 undergraduate students (p. 45). After PLOS criteria assessment, 108 participants were qualified and 64 participants accepted the invitation to participate (p. 45). Participants were assigned to high scrupulosity ($n = 34$) and low scrupulosity ($n = 30$) groups; ^jThe Kapitan and Bhargava (2003) study included contamination/pathogen sensitivity to disgust. It is part of the analysis in Figure 3a; ^kThe Olatunji (2008, p. 1366) and Olatunji, Tolin, Huppert, and Lohr (2005, p. 894) studies are published as different experimental studies. The demographics of the studies indicate similarities. Olatunji, Tolin, Huppert, and Lohr (2005) was included in the analysis; ^lDue to that only a single participant reported that they were a regular churchgoer (>5 times of attendance/month), this assessment was excluded from further analysis (Ottaviani et al., 2013, p. 59); ^mThe specific study explored sensitivity to disgust to Christian participants because the hypothesis was presented and supported by the author(s) that Christian believers have a different context of physical/moral purity compared with other religious groups (Ritter & Preston, 2011, pp. 2–9); ⁿA total of 490 participants, including students and general population participants who were recruited on campus of the Cornell University, Ithaca, were tested. A total of 480 participants reported valid data and were included in the analysis (see Supplemental Material: Study Reports); ^oFive participants did not indicate gender; ^pSeven participants did not indicate age.

samples, $\alpha = \frac{(n_1+n_2)^2}{n_1n_2}$; for a review, see Borenstein et al. (2017, pp. 45–57, 117–125, 239–241, 277–291, 357–364, 377–381).

Results

Overall effects for religiosity and sensitivity to disgust

A zero-order random-effects meta-analysis model was run using the Meta-Correlation in R coding module (see Cheung, 2015) for the final number of included experimental outcomes ($k = 47$). The model revealed a significant positive correlation between religiosity and sensitivity to disgust ($Z = 12.6$; $p < .001$; 95% CI [0.157, 0.215]; $r = .186$). Using standardized meta-analysis estimates including a Fisher's r -to- z transformed correlation coefficient and restricted maximum-likelihood model estimators, the analysis revealed a heterogeneity bias (tau = .075; SE = .002; $p < .001$; $I^2 = 80.11\%$). Hunter–Schmidt covariance corrections were applied and mean age, gender (percentage of females), and type of sample (university student and general population) were included as moderators in the analysis. The mixed-model analysis revealed a non-significant heterogeneity bias ($p = .81$; $I^2 = 9.07\%$). Rosenthal's publication bias fail-safe ($p = .493$) was not significant, and rank funnel plot asymmetry analyses was borderline significant ($p = .049$) for these associations pre-heterogeneity corrections and not significant ($Z = 1.096$; $p = .246$) after corrections for heterogeneity (Borenstein et al., 2017; see Figure 2).

The analysis revealed that age did not have a significant effect on the association between religiosity and sensitivity to disgust (Sobel $z = .26$; $p = .795$; 95% CI [−0.003, 0.004]; $r = .001$). Sample type including student and general population was a marginally significant moderator; however, the effect size was small (Schumm, Pratt, Hartenstein, Jenkins, & Johnson, 2013) for an influence in this association (Sobel $z = -.031$; $p = .085$; 95% CI [−0.067, 0.055]; $r = -.006$). Gender revealed to be a low-effect-size marginally significant moderator (Sobel $z = -1.84$; $p = .066$; 95% CI [−0.003, 0.001]; $r = -.001$). The resulting model revealed a post-adjustment significant and positive correlation between religiosity and sensitivity to disgust ($Z = 5.93$; $p < .001$; 95% CI [0.170, 0.337]; $r = .253$; Figure 2). This result suggests that religiosity and sensitivity to disgust are positively associated irrespectively of age and that this correlation is weakly influenced by sample type and gender (see Figures 2 and 4).

Effects for religiosity and sensitivity to disgust per assessment subtype

We were able to collect additional information for disgust sensitivity to contamination/pathogen-related ($k = 13$) and sexual ($k = 5$) stimuli. Moral sensitivity to disgust was not included due to insufficient research outcomes ($k = 3$). We used the same parameters for the meta-analysis reported in the previous section. We found a significant association between religiosity and contamination/pathogen sensitivity to disgust ($Z = 4.8$; $p < .001$; 95% CI [0.075, 0.180]; $r = .127$). Post-adjustments analysis revealed that after controlling for mean age (Sobel $z = .777$; $p = .437$), gender (Sobel $z = -1.01$; $p = .312$), and type of sample (Sobel $z = .576$; $p = .564$), religiosity and contamination/pathogen disgust were not significantly correlated ($Z = 1.87$; $p = .312$; 95% CI [−0.048, 0.241]; $r = .097$). The same pattern of effects was also reported for religiosity and sensitivity to sexual disgust. A direct meta-analysis revealed that the relationship was significant ($Z = 3.62$; $p < .001$; 95% CI [0.120, 0.404]; $r = .262$). Post-

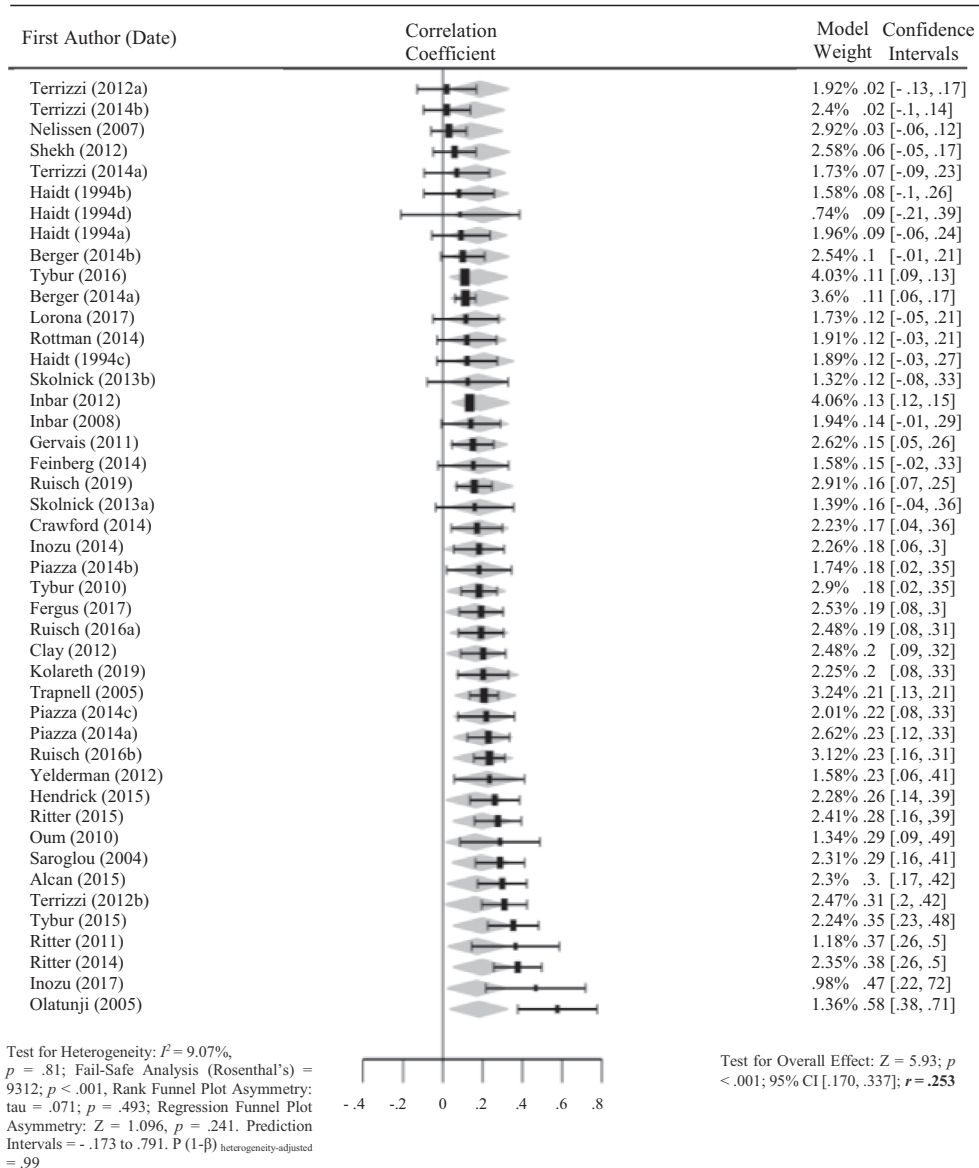


Figure 2. Overall forest plot in observed effect sizes order. The relationship between religiosity and disgust sensitivity provided an overall significant mixed effect. Religious affiliation, political affiliation, and population sample country of origin were not consistently reported in previous research and could not be included in the analysis (see Table 1). Calculations for heterogeneity, meta-statistical power, funnel plot tests, prediction intervals, and meta-analytic power are in the bottom left of the graph.

adjustments analysis revealed a non-significant association ($Z = .128$; $p = .221$; 95% CI [-0.295, 0.458]; $r = .047$). Heterogeneity, funnel plot asymmetry, and publication bias outcomes were significant for these associations (see Figures 3 and 4).

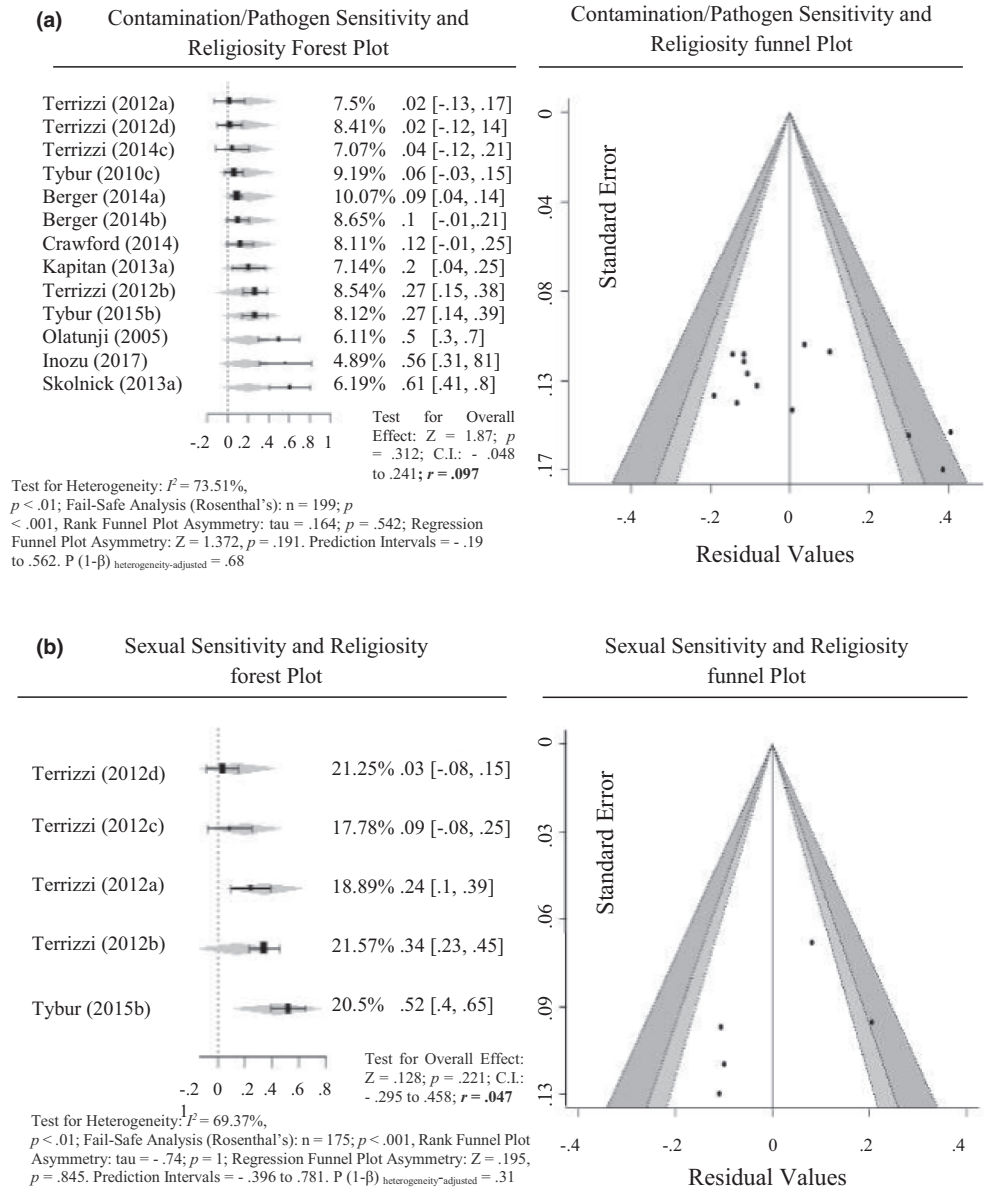


Figure 3. Forest and Funnel Plots for Religiosity and Subtypes of Disgust Sensitivity. In (a) and (b), forest and post-correction funnel plots for pathogen/contamination and sexual sensitivity to disgust, and religiosity, respectively. The analysis revealed significant heterogeneity and funnel plot asymmetry statistical outcomes for the correlational relationships between contamination/pathogen and sexual disgust sensitivity and religiosity. Calculations for heterogeneity, meta-statistical power, funnel plot tests, prediction intervals, and meta-analytic power can be found in the bottom left of each forest plot graph separately.

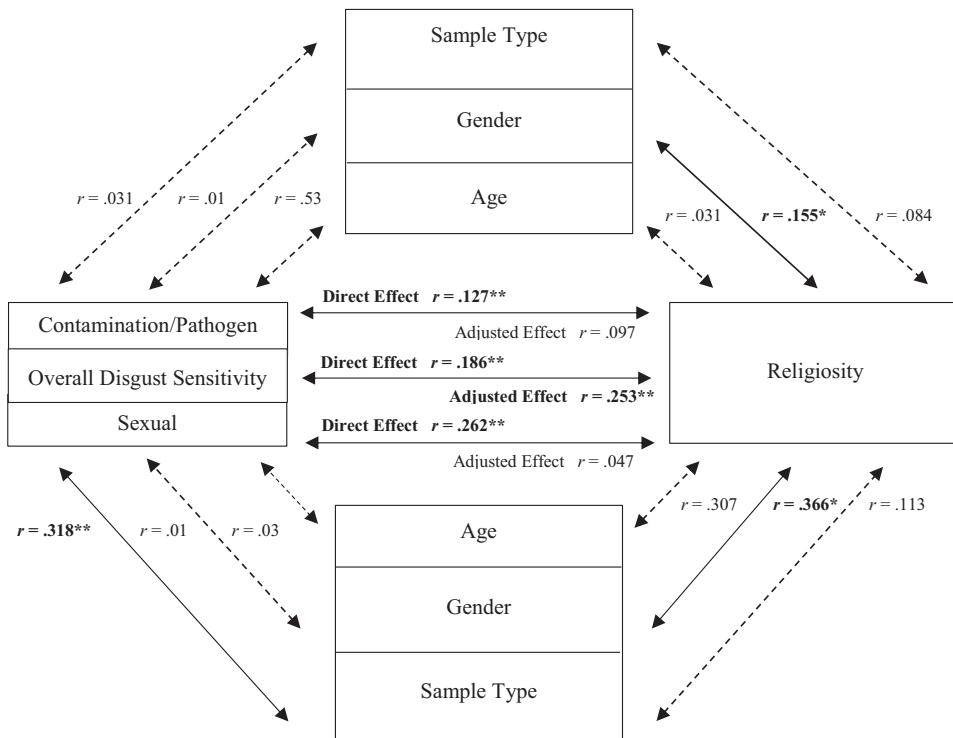


Figure 4. Correlation matrix with correlation analysis between moderator variables (age, gender, and sample type) and disgust sensitivity subtypes and religiosity (see Supplemental Material: Mathematical Coding and Computation). * indicates significance at $p < .05$; ** indicates significance at $p < .01$.

Discussion

Summary of findings

The present study aimed to provide an evaluation of the relationship between religiosity and disgust sensitivity. The current meta-analytic summary showed that there is a positive correlation between religiosity and disgust sensitivity. The overall association between religiosity and sensitivity to disgust was positive ($r = .253$) and significant ($p < .001$) after controlling for heterogeneity, publication bias, parametricity, and adjusting for the effect of moderators, such as gender, sample type (student vs. general), and age (Borenstein et al., 2017; see Figure 2). The present analytic summary also revealed that gender strongly moderated positive associations between religiosity and trait-level sensitivity to disgust subtypes, including pathogen disgust ($r = .127$; $p < .001$) and sexual disgust ($r = .262$; $p < .001$; see, Schumm et al., 2013).

General discussion

Religiosity has been defined as an affiliation with a system of morals and often ritualistic practices that include the belief in the existence and a moral code associated with a transcendental entity, or entities (Fincher & Thornhill, 2012). Sensitivity to disgust has been approached as the belief or self-report that an event, cue, or elicitor will be experienced as aversive to a subject using questionnaire and self-report measures (Rozin

& Haidt, 2013; Tybur et al., 2013). As mentioned in the introduction, theoretical models, such as the societal moral intuition and the EH-PS models, suggest that disgust sensitivity could relate to religiosity as part of a system of beliefs that contribute to moral cognition, emotions, and behaviours. This relationship is suggested to be distinct from the association of secular forms of morality and sensitivity to disgust in the sense that religiosity involves key conceptual differences to secular morality, such as the notions of supernatural invigilation and proportionality (Shariff, 2015).

In the current study, we showed that religiosity positively correlates with sensitivity to disgust. This finding cannot be interpreted to imply causality, such as whether sensitivity to disgust is a predictive marker for religious belief, or vice versa (Beit-Hallahmi, 2014). Instead, it offers the first meta-analytic dedicated findings that religiosity and sensitivity to disgust are, indeed, correlated (Terrizzi et al., 2013). As regards the proposed differences in the evolutionary trajectories between religious and secular factors, that could underlie the reported association, it is worth inquiring whether the relationship between sensitivity to disgust and religiosity can translate to high, or higher, compared to non-religious individuals, physiological reactions in response to disgust-related elicitors (Kapogiannis et al., 2009). The major consideration in this instance is that the result of such an empirical exploration will help to clarify whether the association between religiosity and sensitivity to disgust reflects a theoretical belief framework dissociated from behavioural (see, for example, Argyle, 2006; Beit-Hallahmi & Argyle, 1997; Nelkin, 2000) and physiological responsiveness to stimulus exposure, or an actual physiological module for the avoidance of inferred/indirect threat (Henry, 2016).

This is a very critical distinction. The psychological models that have been associated with religiosity and sensitivity to disgust can be interpreted to suggest that physiological responses will occur when religious individuals are presented with emotional elicitors. The EH-PS model places sensitivity to disgust in relation to religiosity in continuity to an avoidance system related to indirect threat to fitness. Therefore, both disgust-related emotional elicitors and immoral emotional elicitors should stimulate physiological responses for religious individuals that reflect these avoidance mechanisms (Baumard & Boyer, 2013). Conversely, the societal intuitional model has been used to suggest that physiological responses to elicitors related to disgust sensitivity in religious individuals will not only be automatic and involuntary (Boyer & Liénard, 2006) but additionally possibly subject to pre-conscious or subliminal processing, given that their evolutionary origins are linked with intuitional processes (Shariff, 2015).

If these conditions are not met, and if, indeed, sensitivity to disgust does not *translate* to distinct physiological reactions in religious individuals, the arguments that have been proposed to address this association could be reduced to reflect belief systems without palpable physiological correlates (see Shariff, 2015). Along the same lines, the concepts of supernatural invigilation and proportionality suggest that to some extent religious individuals could be subject to deontic, prescriptive, and inviolate moral laws (Shariff, 2015). The expected outcome of this experiential belief to the morality of a transcendental entity – or entities – should be a sense of reduced moral self-authorship (see Dijksterhuis, Preston, Wegner, & Aarts, 2008) as well as a reduced sense of moral self-righteousness and authoritarianism (Haidt, 2012). If subsequent experimental efforts to provide evidence for these effects are not successful, the sceptical scholar could readily attribute the currently reported significant association to the strict and prescriptive laws that are often part of the participation in religious-related ritualistic practices (Barrett, 2000). The association could also be attributed to other moderating factors, such as secular sociosexual attitudes and beliefs (Weeden, Cohen, & Kenrick, 2008) and

addressed as a means for ingroup socialization among morally compatible individuals (Shariff, Willard, Andersen, & Norenzayan, 2016).

As regards our additional findings, we showed that age was not a significant moderator for the association between religiosity and sensitivity to disgust (but see also Dienes, 2014). Several studies have proposed that sensitivity to disgust is higher in younger religious and non-religious adults due to inexperience and inhibitory mechanisms related to experiencing unwanted loss of control and uncertainty (Quigley, Sherman, & Sherman, 1997). Several studies have also suggested that disgust sensitivity can be higher in older/senior religious and non-religious adults possibly due to increased concerns for one's physical and emotional well-being (Oaten, Stevenson, & Case, 2009). Our findings suggest instead that the association of religiosity and sensitivity to disgust is an enduring and not a transient or age-specific effect and that it can manifest throughout an individual's lifespan (Zelenski & Larsen, 2000).

In the most surprising and possibly one of the most important additional findings of our analyses, we showed that gender and sample type had a weak effect-size significance trend influence on the correlation between religiosity and overall sensitivity to disgust. Gender was a significant moderator for the association between religiosity and subtypes of sensitivity to disgust. This finding suggests that gender plays an important role in the association between sensitivity to disgust and religiosity, particularly for sexual and pathogen/contamination-related cues. This could mean that, although religious individuals, independently of gender, have beliefs related to disgust sensitivity, sexual and pathogen/contamination sensitivity to disgust and religiosity are not reliably associated when we remove the effect of the responses of female participants. The meta-analysis matrix adds to this a novel finding. Gender moderated these associations as an interactive function of the effect of female participation in religiosity, although intriguingly female participation did not impact sensitivity to disgust subtypes (see Figure 4). Being female did not directly influence sensitivity to sexual and pathogen/contamination cues as previous studies proposed (Tybur et al., 2013), it increased the level of religiosity of an individual and moderated by association responses to disgust sensitivity subtypes and the interaction between religiosity and sensitivity to disgust. This is a most unexpected, promising, and novel finding that should be further explored by subsequent research.

Looking at the greater picture, in the present manuscript we explored one possible emotional and response attitude, and/or correlate – namely, sensitivity to disgust – that could influence religiosity. This can be the first step for further exploring whether shame, guilt, regret, self-reproach, and – most understatedly in previous psychological research (see, Fatima, Sharif, & Khalid, 2018) – positive-valence emotional states, such as awe, kindness, generosity, and calmness, could underlie and contribute to religious emotional experience and beliefs (Sharma & Singh, 2019). An important contribution of the current outcomes is that we provided evidence that this line of research can offer insightful results, theoretical advances, and further directions for experimental research. These can include the exploration of belief-system response attitudes and emotional correlates of religiosity and their possible distinctive functions within religiosity as possibly non-secular moral and experiential phenomena. The current manuscript could and should (Shariff, 2015) set an experimental and meta-analytic precedence towards the exploration of religiosity and belief-system response attitudes and emotional sensitivity as pathways to understanding religiosity further and in relation to human attitudes and experiences.

Limitations

In the current meta-analyses, the included studies employed questionnaire assessments for assessing the relationship between religiosity and sensitivity to disgust. Future experimental research could benefit from using psychophysiological assessments for exploring this relationship. This implementation will enable us to explore whether the current significant results reflect belief-system values, such as self-report responses, and/or psychophysiological emotional experiences for sensitivity to disgust (see, Tsikandilakis et al., 2021). The current meta-analyses included several different religiosity and disgust sensitivity questionnaire assessments. We must note that an important issue in meta-analytic research is whether the achieved meta-analytic power originates from sufficiently statistically powered studies (see, Amrhein, Trafimow, & Greenland, 2019). This is an important component of meta-analytic research that has, nevertheless, decreased impact in the current meta-analytic research due to the corrected-weighted statistical analyses (see Hedges & Schauer, 2019) of forty-seven experimental outcomes, including 48,971 participants (see also, Borenstein et al., 2017). It is very critical to mention as conclusive remarks that the vast majority of the included outcomes used samples, for which participants' socioeconomic status and political beliefs were not measured. These variables could not be, therefore, included as moderators in the analyses. Exploring their influence should be a priority for experimental replications of the current findings. In addition, the pool of existing empirical studies did not also provide sufficient data to enable the examination across specific religious backgrounds or countries of origin. Further correspondence with the authors of the included studies did not result in sufficient information to perform a per religion analysis or the inclusion of religious affiliation as a categorical moderator in the meta-analysis. Further experimental research could benefit from exploring the effect that different religious affiliations confer on the association between religiosity and sensitivity to disgust.

Conclusions

The main contribution of the current research is that we addressed the relationship of religiosity and sensitivity to disgust as a dedicated phenomenon that should not be downgraded to analytical approaches that assess it as a moderator or a statistically uncorrected footnote for the exploration of political ideologies, and traditional and right-wing authoritarian belief systems. The findings of our exploration for religiosity and sensitivity to disgust were that they are positively associated, and very importantly that gender moderated a positive association between religiosity and sexual and pathogen subtypes of disgust as a function of increased religious affiliation. This should be considered an empirical contribution towards exploring religiosity as a phenomenon in relation to further belief-system attitudes and diverse emotional assessments using experimental and meta-analytic research.

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Conflicts of interest

All authors declare no conflict of interest.

Author contribution

Myron Tsikandilakis (Conceptualization; Data curation; Formal analysis; Funding acquisition; Methodology; Project administration; Software; Supervision; Validation; Writing – original draft; Writing – review & editing) Eddie M.W. Tong (Conceptualization; Formal analysis; Methodology; Supervision; Writing – review & editing) Zhaoliang Yu (Conceptualization; Methodology; Project administration; Validation; Writing – original draft; Writing – review & editing) Persefoni Bali (Conceptualization; Methodology; Validation).

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Supporting Information

The following supporting information may be found in the online edition of the article:

Supinfo S1 Mathematical coding and computations