

Xenophobia or Xenodyskheria? Disgust-driven outgroup prejudice before, during, and after the COVID-19 pandemic

Nassim Elimari^{1*}, Gilles Lafargue¹

¹ *Université de Reims Champagne Ardenne, C2S, UR 6291, France*

**Correspondance: Nassim Elimari, Université de Reims Champagne-Ardenne, Laboratoire C2S, B.P. 30, 57 rue Pierre Taittinger, REIMS Cedex 51171. E-mail address: nassim.elimari@gmail.com*

Abstract

The behavioral immune system, a set of antipathogenic psychological adaptations driven by disgust, has been shown to shape social dynamics and influence outgroup prejudice. Traditional models of xenophobia have historically emphasized the role of fear, stress, and anxiety, potentially overlooking the role of disgust. To better capture the specificity of disgust-driven outgroup prejudice, we introduce the term *xenodyskheria* (from the old Greek *xenos*-(ξένος) = stranger and *-dyskheria* (δυσχέρεια) = *disgust* or *repugnance*). We explore the extent of *xenodyskheria*'s influence on outgroup prejudice before, during, and after the COVID-19 pandemic – arguably one of the most salient pathogen threats of the century. We found that, prior to the pandemic, pathogen disgust had no effect on rejection of and callousness towards healthy looking strangers. However, at the onset of the pandemic, pathogen disgust became the main predictor of outgroup prejudice. In contrast, neither stress nor anxiety were associated with outgroup prejudice during or after the pandemic. Interestingly, we observed a paradoxical relationship between pathogen and moral disgust, as the latter can serve as a “buffer” tempering the exclusionary tendencies of the former, despite these two disgust domains being highly correlated. Additionally, our Post-COVID sample showed no reversion to pre-pandemic levels of *xenodyskheria*, suggesting that the psychological effects of COVID-19 crisis may have left a more enduring imprint on social dynamics than previously assumed. Results are discussed in the light of evolutionary theories. Future research avenues for a dual-process model of behavioral immunity and for pre-genocide dehumanization processes are proposed.

Key words: Xenodyskheria, Behavioral Immune System, Disgust, Outgroup Prejudice, COVID-19, Xenophobia

INTRODUCTION

It is easy to overlook the fact that all living animals, including humans, owe their existence to an unbroken lineage of survivors to the evolutionary arms race against pathogenic microbes, one of the deadliest threats humanity had to face (Barreiro & Quintana-Murci, 2010; Cairns, 1997; Casanova & Abel, 2005). To fight back, animals evolved a sophisticated immune system, but its steep metabolic costs spurred the evolution of complementary pathogen-avoidance behaviors (Hart, 1988, 1990, 2011) that collectively form the ‘Behavioral Immune System’ (BIS, Schaller, 2006). This psychological homolog to its physiological counterpart serves as a first line of defense against contamination by motivating avoidance of disease-causing agents, such as rotting food, feces, or decaying corpses. The visceral reaction the mere mention of these examples may provoke aligns with the prevailing view that the BIS evolved from a primal disgust mechanism aimed at rejecting toxic foods (Rozin et al., 2009), making disgust the affective engine of the BIS, driving most pathogen-avoidance behaviors (see Lieberman & Patrick, 2014, or Schaller, 2014, for potential exceptions).

From Ick to Clique: the “*Xenodyskheria*” hypothesis

A substantial body of research shows that gut reactions also guide social dynamics: the BIS triggers avoidance and rejection of individuals exhibiting disease-connoting cues such as deformities or signs of bacterial infection (Ackerman et al., 2018; Bonin et al., 2019; Curtis et al., 2004; Faulkner et al., 2004; Huang et al., 2011; Navarrete & Fessler, 2006; Thiebaut et al., 2021, 2023, 2024; Tybur et al., 2013). Parasite-stress theories of outgroup prejudice assert that ‘*foreignness*’ was another heuristic cue linked to pathogen threats in our evolutionary past: the BIS interprets *foreignness* as *contagiousness* because foreigners were likely to (1) violate local pathogen-mitigating norms (e.g., hygiene, diet, sacred rules, Fessler & Navarrete, 2003; Murray & Schaller, 2012; Tybur et al., 2016), or (2) carry novel pathogens against which local immune systems were still naive (Bressan, 2021, 2023; Fincher & Thornhill, 2012; Kramer & Bressan, 2021; Thornhill et al., 2009). Extensive research has indeed linked disgust to avoidance and rejection of outgroups (Ackerman et al., 2018; Schaller & Duncan, 2016; Schaller & Park, 2011; Terrizzi et al., 2013; Tybur et al., 2013).

Interestingly, this ‘gut factor’ has lingered as an often-overlooked force in the scientific study of outgroup prejudice. Classical theories of xenophobia argue that hostility toward foreigners arises from them being seen as threats to the ingroup’s safety, prosperity, and well-being (Greenberg et al., 1986; Mayda, 2006; Navarrete et al., 2004; Stephan et al., 1999, 2015; Stephan & Stephan, 2013). Thus, stress, fear, and anxiety have been widely investigated and rightfully recognized as core affective ingredients of outgroup prejudice (Delanty, 2008; Esses et al., 2001; Greenberg et al., 1990; Gudykunst, 1995; Pettigrew et al., 2011; Stephan & Stephan, 1985; Stephan et al., 1999), a research focus presumably exacerbated by the semantic notions conveyed by the suffix *-phobos*. However, outgroup prejudice is a complex and multifaceted phenomenon that can stem from various cognitive or affective processes, including disgust. To clarify: we do not claim that stress-mediated prejudice (*xenophobia*) never occurs, but rather that disgust-mediated prejudice is a distinct psychological construct involving domain-specific (1) elicitors, (2) processing pathways, and (3) behavioral outputs. We dub this disgust-driven outgroup prejudice “*xenodyskheria*”: from *xenos*-(*ξένος*) = stranger and *-dyskheria* (*δυσχέρεια*) = *disgust* or *repugnance*, often in the context of diseases,

socially revolting behaviors, sexual deviances, or moral transgressions¹ (see Lateiner & Spatharas, 2016, for an in-depth discussion). Given its unique features, *xenodyskheria* merits investigation in its own right, with separate research avenues exploring its dynamics and underpinning mechanisms.

A moral buffer against xenodyskheria: the irony of gut feelings turned moral outrage

Over evolutionary time, the neural circuits of disgust have been repurposed to guide behaviors in other domains, including sexuality and morality (Rozin et al., 2008, 2009; Tybur et al., 2009; 2013). The revulsion we feel toward immoral behaviors is not merely metaphorical: akin to rotten food or open sores, moral violations are often viewed as disgusting, which led to the proposition that the BIS drives rejection of immorality (Chapman & Anderson, 2012, 2013; Chapman et al., 2009). The disgust-morality connection is evidenced by several lines of research. Disgust and moral indignation elicit neural activity in overlapping brain structures (Moll et al., 2005; Schaich-Borg et al., 2008; Ying et al., 2018) and their relationship is bidirectional: immoral elicits disgust, while disgust triggers harsher moral judgments (Chapman & Anderson, 2013). For instance, recalling immoral deeds increases the need for cleansing (Zhong and Liljenquist, 2006), while exposure to disgusting odor intensifies moral condemnation (Schnall et al., 2008).

Evolutionary theories suggest that phylogenetically recent neurocognitive adaptations typically involve more domain-general, flexible, high-order, controlled processes (Anderson, 2014; 2016; Badcock et al., 2019a, 2019b; Barrett & Kurzban, 2006, 2012; Elimari, 2023; Elimari & Lafargue, 2020, 2023a, 2023b, 2024). Following this logic, moral disgust is likely more flexible and domain-general than older BIS subsystems. Integrating both disgust-related information and moral constructs, moral disgust should display a “cultural plasticity” contrasting with the automatic, knee-jerk gut reactions of pathogen disgust. Ironically, the BIS itself might already hold the key to control its own exclusionary tendencies. A thus surprisingly overlooked question in BIS research is whether moral disgust can act as a buffer against gut instincts. For instance, may viewing outgroup prejudice morally repugnant result in a “behavioral immune paradox”, where ancient gut instincts amplify prejudice while moral disgust works to suppress it?

Though it stands to reason that a high repugnance towards prejudice or bigotry would foster outgroup openness, few studies have explored moral disgust as a driver of openness or prosociality (see Oriol et al., 2023, or Chu et al., 2024, for exceptions). Moreover, the greater evolutionary recency of moral disgust (Curtis et al., 2011; Kelly, 2011; Rozin et al., 2009; Tybur et al., 2009) suggests processing pathways more permeable to high-order cognition and cultural fluctuations in social, philosophical, political, or legal ideas, potentially protecting it against the BIS reactivity to pathogen threats. We propose highlighting this dynamic by showcasing that pathogen and moral disgusts (two closely related BIS subsystems) can yield antagonistic responses.

The present study: *xenodyskheria* before, during, and after pandemics

The COVID-19 crisis, arguably the most prominent pathogen threat to 21st century Western societies, provided a grim yet fitting context for testing the *xenodyskheria* hypothesis. COVID-related research has provided mixed results regarding the link between disgust,

¹ For instance, the aptonymous “*Duscheres*” character in Theophrastus’ *Characters* “does not care that his body is scabrous, sore-ridden, hairy, dirty, and smelly, and his unpleasant personal habits include nose-wiping while talking, spitting, belching, and sleeping with his wife without washing” (see Fisher, 2016, in Lateiner & Spatharas, 2016)

pathogen threats, and outgroup prejudice. For instance, a large-scale study identified pathogen disgust as the strongest predictor of negative feelings toward foreigners, surpassing gender, age, conservatism, germ aversion, and perceived infectability (Hromatko et al., 2021). Similarly, the correlation between germ aversion and a dislike for social touch significantly increased during the pandemic (Thiebaut et al., 2021). In contrast, a four-wave longitudinal study spanning from May 2020 to June 2022 found no change in outgroup prejudice or disgust-prejudice correlation (Fan et al., 2024). However, Fan et al.'s procedure was somewhat specific, with immigrant descriptions introducing moderators (e.g., wealth, altruism), potentially smoothing differences across time and participants. Further mixed findings concern the context-specific activation of the BIS: while some studies observed that pathogen disgust (Fan et al., 2024) and germ aversion (Thiebaut et al., 2021) increased alongside pathogen threat, others observed no such elevation but increases (Schwambergova et al., 2023) or decreases (Milkowska et al., 2021) in moral disgust instead. In another study, Hlay and colleagues (2021) found that the perceived risk to contract the SARS-CoV-2 virus was positively associated with pathogen disgust, whereas the objective risk (i.e., state case rates) were in fact negatively associated pathogen disgust.

These mixed findings likely stem from two implicit assumptions (but see Hlay et al., 2021, for alternative explanations). First, many researchers assumed that incidence and death rates directly reflected pathogen threat. However, the extensive media coverage of the pandemic likely made perceived threat and COVID anxiety driven more by media exposure than actual case numbers² (Calvillo et al., 2020; Motta et al., 2020; Sorokowski et al., 2020; Wheaton et al., 2021). Second, some authors intuitively assumed that BIS activation increases linearly with pathogen threat. However, recent perspectives from connectomics emphasizes the importance of brain connectivity, rather than localized activation, in complex cognitive processes: the brain does not simply “turn on” one region, it dynamically reorganizes information integration within and between networks (Badcock et al., 2019a, 2019b; Elimari, 2023; Elimari & Lafargue, 2020, 2023b; Herbet & Duffau, 2020). This has subtle but important implications: BIS activation may not simply involve “more disgust” but rather reflects organizational shifts in network connectivity. Thus, the contextual effects of behavioral immunity on outgroup prejudice may depend more on changes in strength of disgust-prejudice relationships than on mere activation.

Keeping all that in mind, the present study assesses changes in strength of relation between disgust, stress, anxiety, and outgroup prejudice. To avoid relying on speculative relations between death rates, media exposure, and BIS activation, we opted to compare three samples recruited, before, during, and after the pandemic. We propose 3 hypotheses:

1. The “*xenodyskheria*” hypothesis: disgust will be the most potent predictor of outgroup prejudice, compared to stress and anxiety.
2. The “*moral buffer*” hypothesis: despite being correlated with pathogen disgust, moral disgust should be associated with a decrease in outgroup prejudice.
3. The “*contextual xenodyskheria*” hypothesis: this exploratory hypothesis does not entail precise predictions. Rather, we expect our *xenodyskheria* hypothesis to be significantly more relevant during the pandemic than before or after. As argued, moral disgust is less likely to fluctuate along with BIS activations and to depend on more stable moral constructs. Thus, we do not expect the *moral buffer* hypothesis to be context dependent.

² Though this is a mundane statement, it is also worth reminding that the behavioral immune system is an evolved adaptation, not a designed precision instrument. Consequently, mathematical estimates of death rates likely hold little significance as cues of environmental pathogens.

To the best of our knowledge, this study is the first to directly compare the *xenodyskheria* hypothesis with standard xenophobia models in the context of a real-world pathogen threat. However, previous research has examined disgust-mediated prejudice using a similar protocol (Van Leeuwen & Petersen, 2018). We have repurposed their dataset as our “*pre-COVID*” sample. While we acknowledge the limitations of this approach, we nonetheless believe that it provides a useful frame of reference.

METHOD

Participants and samples

The present study utilizes 3 distinct samples: a peak-COVID sample, a post-COVID sample, and a retrospectively sourced pre-COVID sample (Van Leeuwen & Petersen, 2018).

The Peak-COVID sample ($n = 1542$, 836 females, 694 males, 12 non-binary, M age = 33.1 years, $SD = 10.2$) was recruited using social media (Facebook, Reddit) at the height of the pandemic during the “*Winter Wave*” of 2020-2021 (for the first time since the pandemic began, COVID-19 new daily cases exceeded 200 000 on 2 December 2020, and peaked on 8 of January with 314 180 new daily cases, source: COVID Data Tracker, <https://covid.cdc.gov>). Though this situation was gruesome, the heightened pathogen threat likely triggered paroxysmal activity of the BIS. Data collection took place from 30 November 2020 to 15 January 2021.

To maintain similar conditions, the Post-COVID sample ($n = 500$, 260 females, 239 males, 1 non-binary, M age = 35.3 years, $SD = 11.02$) was recruited using social media (Facebook, Reddit) and Prolific from 11 December 2023 to 30 January 2024, during the first winter following the official end of the pandemic on May 5, 2023. Barriers and drivers of COVID-19 vaccination, kin altruism, and political affiliation were also measured and are discussed in another article.

The pre-COVID sample was sourced from open-access data of a prior online study (Van Leeuwen and Petersen, 2018) that assessed behavioral immunity and outgroup prejudice using similar measures (see Materials). Notably, Van Leeuwen and Petersen manipulated pathogen threat by photoshopping half the targets with apparent facial skin lesions. For our analyses, in order to make their sample as comparable as possible to ours, we focused exclusively on a subset of their participants ($n = 895$, 320 females, 575 males, M age = 33.4 years, $SD = 9.71$) exposed to healthy-looking outgroup targets.

This study was conducted in full compliance with the standards set by the American Psychological Association, the principles outlined in the Declaration of Helsinki (2008), and laws regarding ethics for social science. Participation was fully voluntary. All participants provided informed consent, were made aware of their right to withdraw at any point without need for justification, and were ensured full anonymity and confidentiality in the handling of their data. No sensitive or personally identifiable information was collected.

Materials

First, participants reported their age, biological sex, gender identification, country of residence, profession, and perceived seriousness of the pandemic. Then, questionnaires assessing predictors (i.e., behavioral immunity, stress, anxiety) and outcome variables (outgroup rejection, outgroup callousness) were presented in a pseudo-randomized order. Willingness to vaccinate, body representations, kin altruism, and interdependence were also measured and are discussed in another article.

Behavioral Immunity was assessed using the Three-Domain Disgust Scale (TDDS, Tybur et al., 2009). Its three subscales are composed of 7 items each describing a suite of potentially disgusting situations involving pathogenic agents (e.g., “Stepping on dog poop”), sexual behaviors (e.g., “Hearing two strangers having sex”), and morally questionable acts (e.g., “Deceiving a friend”). Participants report how disgusting they consider each of the 21 situations on a scale from 0 to 6. Cronbach’s alphas for the pathogen disgust (Peak-COVID, $\alpha=.76$, Post-COVID, $\alpha=.81$), sexual disgust (Peak-COVID, $\alpha=.80$, Post-COVID, $\alpha=.82$), and moral disgust (Peak-COVID, $\alpha=.84$, Post-COVID, $\alpha=.89$) subscales all showed good internal reliability.

Anxiety and stress were assessed with the Depressive, Anxiety, and Stress Scale (Lovibond & Lovibond, 1995). Cronbach’s alphas for the stress subscale (Peak-COVID, $\alpha=.88$, Post-COVID, $\alpha=.90$) and anxiety subscales (Peak-COVID, $\alpha=.82$, Post-COVID, $\alpha=.85$) showed good levels of internal reliability.

Outgroup prejudice was evaluated using 2 metrics: outgroup rejection and outgroup callousness. Outgroup rejection was inferred from comfort with contact using an adapted version of the Social Distance Scale (Bogardus, 1933), presenting 8 pictures of healthy-looking strangers (4 females, 4 males) from various outgroups (Chinese, Italian, Nigerian, and Slovenian) sourced from the Chicago Face Database (Ma et al., 2015, average attractiveness, neutral expression). After viewing each photo and a brief description (name, country of origin), participants rated on a 7-point scale the minimum proximity at which they felt comfortable with each target. Comfort with physical/social contact has long served as a proxy for prejudice in various contexts (Binder et al., 2009; Pettigrew & Meertens, 1995; Vanneman & Pettigrew, 1972; Weaver, 2008), including the pandemic (Olivera-La Rosa et al., 2020; Sorokowski et al., 2020). Cronbach’s alphas showed good internal reliability (Peak-COVID, $\alpha=.94$, Post-COVID, $\alpha=.93$).

We also assessed altruism, addressing the relatively underexplored influence of the BIS on prosocial tendencies. Participants were asked to report their willingness to help and care for each target if they had contracted the SARS-CoV-2 virus (from “1. I would refuse completely” to “7. I would be glad to help”). Scores were reversed to form an index of “outgroup callousness”, representing a lack of altruism toward outgroups. Cronbach’s alphas showed good internal reliability (Peak-COVID, $\alpha=.99$, Post-COVID, $\alpha=.98$).

Van Leeuwen and Petersen’s study also utilized the TDDS as their measure of behavioral immunity. The authors also assessed outgroup prejudice by asking participants to report their comfort with contact in relation to strangers shown in pictures. Similarly, they assessed prosocial tendencies by asking participants to report their willingness to help strangers if they happened to feel unwell. The authors did not however assess stress or anxiety, so comparisons will focus on disgust and prejudice.

Data analyses

First, we examined relations between all relevant variables with zero-order correlations. Since Van Leeuwen and Petersen’s study did not assess stress or anxiety, analyses focus on domains of disgust for the Pre-COVID sample. Following the *xenodyskheria* and the *contextual xenodyskheria* hypotheses, we expect (1) stronger correlations between pathogen disgust and outgroup prejudice (2) during the pandemic only. Also, following the *moral buffer* hypothesis, we predict that moral disgust will be negatively correlated with outgroup prejudice despite being highly correlated with other domains of disgust, and that this relation will not significantly vary as a function of pathogen threat.

Then, we used structural equation modelling (SEM) to assess relations between predictors and outgroup prejudice while controlling for covariances between variables. Since disgust, stress, and anxiety are typically correlated, those predictors may all appear to be related to outgroup prejudice, even if no direct relation exist. SEM is well-suited for disentangling true variable relations by controlling for shared variances. Due to the absence of item-level data in Van Leeuwen and Petersen's dataset, we were unable to perform a Pre-COVID SEM analysis. Translating our hypotheses into our hypothesized model (Figure 2), we expected (1) pathogen disgust to upregulate outgroup prejudice during the pandemic but to have little to no influence after the pandemic, (2) moral disgust to downregulate outgroup prejudice regardless of context, and (3) neither stress nor anxiety to upregulate outgroup prejudice during the pandemic but may have a significant effect after.

3. RESULTS

3.1. Behavioral immunity, stress, and anxiety as predictors of outgroup prejudice before, during, and after the pandemic

Table 1 presents the Bonferroni-corrected correlations among all predictors (i.e., pathogen disgust, sexual disgust, moral disgust, anxiety, and stress) and outcome variables (i.e., outgroup rejection, outgroup callousness), along with their corresponding skewness and kurtosis values. Results revealed three distinct trends for each domain of disgust. Before the pandemic, pathogen disgust showed no correlation with either outgroup rejection or callousness. However, it became a significant predictor of both rejection ($r = .26$) and callousness ($r = .22$) at the height of the pandemic. Interestingly, contrary to our *contextual xenodyskheria* hypothesis, correlations did not revert to Pre-COVID levels after the pandemic, as pathogen disgust kept correlating with rejection ($r = .31$) and callousness ($r = .25$). Sexual disgust exerted a similar but more modest effect, predicting higher outgroup prejudice during, and after the pandemic only (from $r = .16$ to $r = .22$). Contrary to its counterparts, but consistent with our *moral buffer* hypothesis, moral disgust was negatively correlated with outgroup callousness before ($r = -.13$) and during ($r = -.12$) the pandemic. Finally, no correlation was observed between stress or anxiety and outgroup prejudice.

Table 1. Zero-order correlations, Kurtosis, and Skewness for all predictors and outgroup prejudice before, during, and after the COVID-19 pandemic

	Rejection	Callousness	Patho	Sexual	Moral	Anxiety	Stress
Pre-COVID							
Rejection		.42***	.04	.05	-.07	--	--
Callousness			-.06	.09	-.13**	--	--
Patho				.48***	.50***	--	--
Sexual					.45***	--	--
Kurtosis	-.42	{-1.04}	.04	-.88	.18		
Skewness	-.34	{.31}	-.41	-.01	-.66		
Peak-COVID							
Rejection		.37***	.26***	.19***	-.04	.07	.04
Callousness			.22***	.16***	-.12***	.03	.04
Patho				.39***	.21***	.07	.10*
Sexual					.17***	.05	.06
Moral						-.05	-.01
Anxiety							.72***

Kurtosis	.45	-1.17	-.30	.09	1.15	{-.63}	-.52
Skewness	.75	.01	-.16	.57	-.86	{.43}	.32
Post-COVID							
Rejection		.46***	.31***	.22***	.09	.05	.03
Callousness			.25***	.15*	-.08	.05	-.01
Patho				.41***	.28***	.10	.10
Sexual					.25***	-.01	-.02
Moral						.04	.03
Anxiety							.77***
Kurtosis	-.34	-1.01	-.04	-.62	-.83	{-.36}	-.17
Skewness	.38	0.75	-.43	.26	-.95	{.59}	.73

*Note: After Bonferroni corrections, * $p < .005$, ** $p < .001$, *** $p < .0001$ for the Pre-COVID sample. * $p < .002$, ** $p < .001$, *** $p < .0001$ for the Peak-COVID and Post-COVID samples. Values between brackets represent kurtosis and skewness after logarithmic transformation.*

Furthermore, correlations between predictors revealed an interesting pattern. Before the pandemic, pathogen, sexual, and moral disgust were strongly interrelated, with correlations going from $r = .45$ to $r = .50$. During the pandemic however, the internal consistency of the BIS drastically weakened, as reflected in the changing correlations across domains of disgust. For instance, the correlation pathogen disgust and sexual disgust dropped significantly, from $r = .48$ to $r = 0.39$ (Fisher's $z = 2.64$, $p = .004$). The most pronounced declines were seen in moral disgust's relationship with the two other domains: its correlation with pathogen disgust plummeted from $r = .50$ to $r = .21$ ($z = 7.99$, $p < .001$), and with sexual disgust, from $r = .45$ to $r = .17$ ($z = 7.44$, $p < .001$).

Interestingly, the diminished internal consistency within the BIS did not fully return to pre-pandemic levels Post-COVID. Correlations between pathogen and sexual disgust recovered slightly to $r = .41$ but remained marginally below its pre-pandemic value ($z = 1.56$, $p < .059$). Similarly, correlations between moral disgust and pathogen disgust ($z = 4.68$, $p < .001$) and sexual disgust ($z = 4.10$, $p < .001$) showed modest increases compared to the pandemic's peak, they were still significantly lower than their pre-COVID levels, suggesting once again lingering effects of the COVID crisis on BIS activation. Predictably, anxiety and stress were highly correlated both during ($r = .72$) and after ($r = .77$) the pandemic. A small but significant correlation also emerged between pathogen disgust stress during the pandemic ($r = .10$). The correlations observed between predictors (especially between domains of disgust) underscore the need for structural equation modeling to untangle complex covariances between predictors.

3.2. Changes in relationship between disgust, stress/anxiety, and outgroup prejudice before, during, and after the COVID-19 pandemic

As a baseline frame of reference, we conducted two multiple linear regression analyses on the Pre-COVID sample, using the three disgust domains as predictors, with outgroup rejection and callousness as distinct outcome variables. Results showed that pathogen disgust did not predict outgroup rejection ($\beta = .065$, $p = .110$) or callousness ($\beta = -.061$, $p = .129$) before the pandemic (see Fig. 3). However, sexual disgust was positively associated with rejection ($\beta = .078$, $p = .048$) and callousness ($\beta = .197$, $p < .001$). Similarly, moral disgust was negatively associated with rejection ($\beta = -.133$, $p = .001$) and callousness ($\beta = -.182$, $p < .001$). As a reminder, we focused on Van Leeuwen and Petersen's (2018) data involving outgroup targets

with unaltered faces. These findings suggest that, in the absence of overt signs of bacterial infection, pathogen disgust did not significantly increase rejection or callousness towards outgroup targets (see Van Leeuwen & Petersen, 2018, for results related to targets exhibiting disease cues).

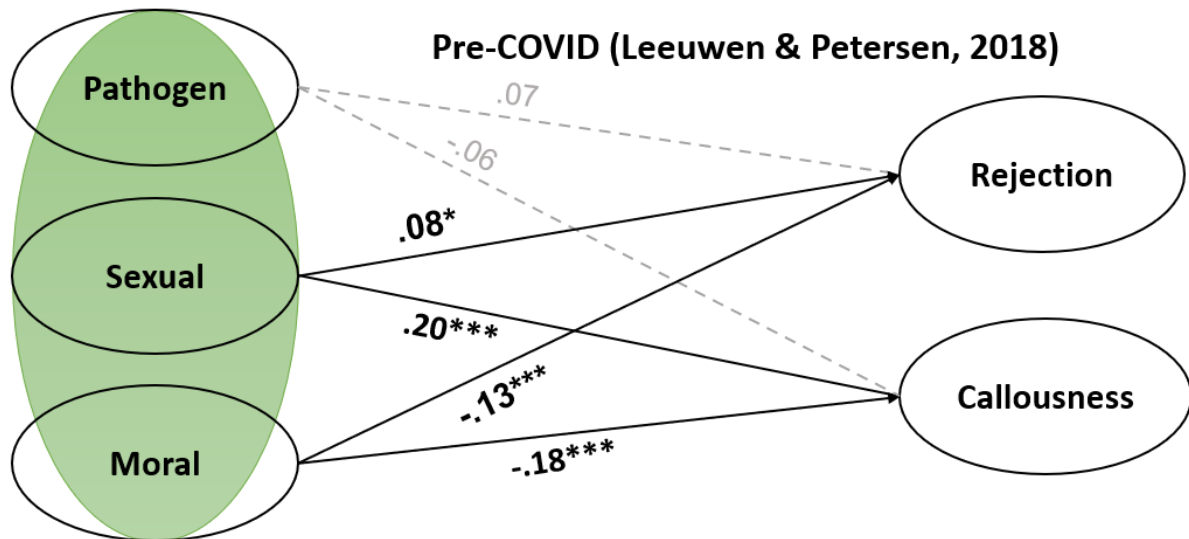


Figure 3. Beta coefficients as derived from multiple regression analyses showing the relations between domains of disgust and outgroup prejudice Pre-COVID pandemic. We observed no significant influence of pathogen disgust, but sexual and moral disgust exerted mutually opposing influences on both outgroup rejection and callousness: sexual disgust upregulated prejudice, while moral disgust downregulated it.

Then, we computed multi-group structural equation modelling (SEM) analyses computed with period (during/after the pandemic) as a multi-group factor to investigate the effect of behavioral immunity, stress, and anxiety on outgroup rejection and outgroup callousness. To ensure robustness of our findings, we used six goodness-of-fit indices to evaluate the adequacy of our model fit: relative chi-squared ($\chi^2/df \leq 3.00$), the Comparative Fit Index (CFI ≥ 0.900), the Tucker Lewis Index (TLI ≥ 0.900), the Goodness of Fit Index (GFI ≥ 0.900), the Standardized Root Mean Squared Residual (SRMSR ≤ 0.06), and the Root Mean Square Error of Approximation (RMSEA ≤ 0.08). SEM analyses revealed a good fit for the overall model: SRMSR = 0.044; RMSEA = 0.043; χ^2/df ratio = 2.83; CFI = 0.944; TLI = 0.941; and GFI = 0.960. A chi-square difference test confirmed significant variation between the Peak-COVID and post-COVID groups, $\chi^2(54) = 111.09$, $p < .001$, allowing for separate path analyses for each period.

At the height of the pandemic, all three forms of disgust predicted outgroup rejection: both pathogen disgust ($\beta = .305$, $p < .001$) and sexual disgust ($\beta = .081$, $p = .015$) were associated with increased rejection, whereas moral disgust was associated with less rejection ($\beta = -.134$, $p < .001$). In contrast, neither anxiety ($\beta = .088$, $p = .265$) nor stress ($\beta = -.057$, $p = .469$) had any significant influence on outgroup rejection. A similar pattern was observed with outgroup callousness. Pathogen disgust predicted higher callousness ($\beta = .284$, $p < .001$) while moral disgust predicted lower levels of callousness ($\beta = -.220$, $p < .001$). On the other hand, sexual disgust had no significant influence on callousness ($\beta = .054$, $p = .103$), and neither did anxiety ($\beta = -.040$, $p = .611$) nor stress ($\beta = .057$, $p = .465$).

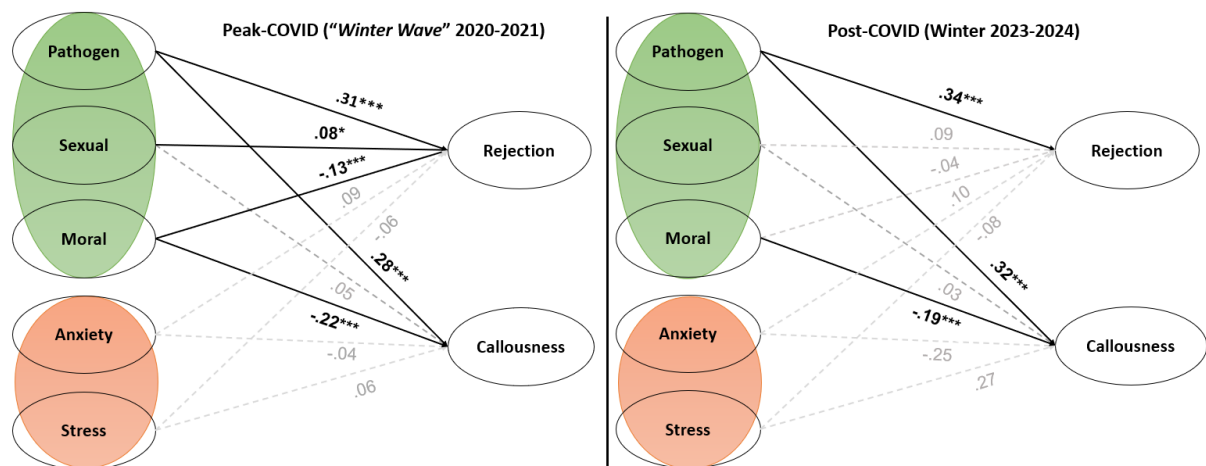


Figure 4. Beta coefficients (* $p < .05$, ** $p < .01$, *** $p < .001$) derived from structural equation modeling analyses showing the relationships between domains of disgust (i.e., behavioral immunity, in green), stress/anxiety (in pink), and outgroup prejudice, during and after the COVID-19 pandemic. At the pandemic's peak, all three disgust domains significantly predicted outgroup rejection, whereas only pathogen disgust continued to do so post-pandemic. The influence of the behavioral immune system on callousness remained consistent throughout both periods, with pathogen increasing callousness and moral disgust exerting a mitigating effect. In all instances, moral disgust counteracted the exclusionary tendencies triggered by pathogen disgust. Consistent with our xenodyskheria hypothesis, neither stress nor anxiety emerged as significant predictor of outgroup prejudice at any point.

After the pandemic, only pathogen disgust continued to influence outgroup rejection ($\beta = .338$, $p < .001$). In contrast, sexual disgust ($\beta = .093$, $p = .106$), moral disgust ($\beta = -.042$, $p = .399$), anxiety ($\beta = .010$, $p = .530$), and stress ($\beta = -.083$, $p = .599$) no longer exerted significant effects on outgroup rejection. Interestingly, the post-pandemic effects on outgroup callousness mirrored those observed during the pandemic. Pathogen disgust predicted higher callousness ($\beta = .324$, $p < .001$) and moral disgust predicted lower callousness ($\beta = -.187$, $p < .001$), exerting the same opposite effects. On the other hand, sexual disgust ($\beta = .031$, $p = .593$), anxiety ($\beta = -.248$, $p = .124$), and stress ($\beta = .265$, $p = .096$) remained non-significant influences.

DISCUSSION

This study compared the *xenodyskheria* hypothesis with traditional xenophobia models, investigating whether disgust is a stronger driver of outgroup prejudice than stress or anxiety in the context of a pathogen threat. Using the COVID-19 pandemic as a real-world pathogen threat, we tested three hypotheses: (1) disgust would become a stronger predictor of outgroup prejudice than stress or anxiety, (2) moral disgust would counteract the exclusionary tendencies triggered by pathogen disgust, and (3) *xenodyskheria* would be amplified during the pandemic rather than before or after.

Results showed that pathogen disgust had no significant effect on outgroup prejudice in the Pre-COVID sample (Van Leeuwen & Petersen, 2018) but started to be strongly associated with prejudice during and after the pandemic. The effect of sexual disgust on outgroup prejudice followed the same pattern, though with weaker correlations. In contrast, moral disgust was associated with a decrease in outgroup callousness. Additionally, neither stress nor anxiety were significantly associated with prejudice during or after the pandemic, in full accordance with the *xenodyskheria* hypothesis. Interestingly, we also observed a reduction in the internal consistency of the BIS: the correlations between disgust domains was significantly higher pre-pandemic than during or after the COVID-19 crisis. This reinforces

the previously suggested notion that BIS “activation” may not simply be reflected in “more disgust”, but rather in reorganizational shifts within the BIS, consistent with recent neuroscientific and evolutionary syntheses and models (Badcock et al., 2019a, 2019b; Calhoun et al., 2014; Elimari, 2023; Elimari & Lafargue, 2020, 2023b; Herbet & Duffau, 2020; Kopell et al., 2014). Future research should focus on how these shifts drives new information-processing dynamics and thus, new attitudinal, affective, and behavioral outputs.

We then examined changes in strength of relation between variables with multiple regression analyses and structural equation modeling, providing additional insights. For instance, regression analyses in the Pre-COVID sample showed that sexual disgust was in fact associated with both higher rejection and higher callousness, and that the buffering effect of moral disgust on callousness extended to outgroup rejection. Focusing on Peak-COVID and Post-COVID samples, SEM analyses revealed that, once accounting for covariances, sexual disgust lost most of its influence on outgroup prejudice during the pandemic. Similarly, we confirmed the buffering effect of moral disgust on outgroup prejudice during the pandemic, and found that it extended post-COVID to outgroup callousness. Importantly, SEM analyses confirmed that neither stress nor anxiety had any significant influence regardless of period. Overall, multi-group SEM comparisons highlighted significant changes in relationships across pandemic phases: during the pandemic, all three disgust domains significantly influenced rejection during the pandemic, whereas post-pandemic, only pathogen disgust had a notable effect. The influence of the BIS on outgroup callousness however remained consistent, with pathogen disgust predicting higher levels and moral disgust predicting lower levels.

Parasite-stress theories and xenodyskheria

Our findings are consistent with parasite-stress theories of outgroup prejudice (Bressan, 2021, 2023; Fessler & Navarrete, 2003; Fincher & Thornhill, 2012; Kramer & Bressan, 2021; Murray & Schaller, 2012; Thornhill et al., 2009; Tybur et al., 2016) and strongly support the *xenodyskheria* hypothesis: directly comparing disgust, stress, and anxiety, we found that disgust domains exert far greater influence on prejudice against foreigners than stress and anxiety. It is worth noting that Van Leeuwen and Petersen (2018) found that disgust predicted outgroup rejection only when disease cues were evident (but see Bressan, 2021, for a reinterpretation of the same data). However, our results indicate that starting from the pandemic onward, pathogen disgust drove prejudice even against healthy-looking foreigners. This shift supports the contextual xenodyskheria hypothesis but, contrary to our predictions, prejudice levels did not revert to Pre-COVID baseline post-pandemic.

This may reflect lingering psychological impact of the pandemic: perhaps many participants were unaware of WHO’s official statement regarding the end of the pandemic, perhaps official statements hold little significance for the BIS, or perhaps pathogen threats naturally leave a more enduring imprint on the mind than previously assumed. The pandemic might have primed the BIS for hypervigilance toward pathogen risks, even minor, long after the COVID-19 threat has dissipated. This aligns with both intragroup (i.e., prejudice arises from rejection of local norms violators) and intergroup (i.e., prejudice stems from avoidance of outsiders who may carry non-local pathogens) accounts of parasite-stress theories. Such hypervigilance could manifest as increased societal fixation on norm adherence and a greater perception of foreigners as norm-violators, or in a more straightforward aversion towards foreigners who might carry novel pathogens.

Several limitations prevent us from drawing clear conclusions from our results. A key issue is the inconsistent assessment of moderators that could clarify the relationship between disgust and xenodyskheria, such as traditionalism and social dominance orientation (e.g., Tybur et al.,

2016). We did assess political orientation in the Post-COVID sample, but in a rather simplistic manner (i.e., a single Likert item from “1. Liberal” to “9. Conservative”). Interestingly, the correlations between political affiliation and outgroup rejection ($r = .15, p = .001$) or callousness ($r = .05, p = .297$) were weaker than those between pathogen disgust and rejection ($r = .31, p < .001, z = 2.57, p = .007$) and callousness ($r = .25, p < .001, z = 3.24, p = .001$). This pattern aligns more with intergroup than intragroup accounts of parasite-stress theories, but our crude measure and inconsistent assessments limit the scope and robustness of our conclusions.

A more substantial limitation is that our study was not longitudinal. Instead, we compared three distinct samples, repurposing Van Leeuwen and Petersen’s (2018) dataset for a pre-COVID baseline. Consequently, we lacked Pre-COVID data on stress and anxiety. Plus, we cannot rule out the possibility that our findings are influenced by sampling biases, despite similar recruitment methods. While our focus was on changes in the strength of association between variables rather than absolute levels of disgust or prejudice, a longitudinal design would have provided additional insights into contextual activations, on which we must, given the present circumstances, remain speculative.

Lastly, measures of outgroup prejudice are extremely sensitive to social desirability bias and participants likely underreported prejudice. For instance, in the Peak-COVID sample, only 20 participants reported the highest possible score of outgroup rejection, while 321 reported the lowest. Consequently, the effects observed in the present study are presumably less pronounced than in real-world settings. Future research on xenodyskheria should prioritize implicit and physiological measures for more solid conclusions.

A dual-process view of behavioral immunity

Our results also lend credence to our “moral buffer” hypothesis. Moral disgust is intrinsically linked to pathogen disgust, as both covary and show bilateral coactivation (Chapman & Anderson, 2013; Schnall et al., 2008; Zhong & Liljenquist, 2006), a pattern reflected in our results too. However, they influenced outgroup prejudice in opposite ways – while pathogen disgust amplified prejudice, moral disgust tempered it. Notably, the effect of moral disgust remained stable across all three phases studied, reinforcing the notion (further discussed below) that moral disgust might be more resistant to BIS activations than pathogen or sexual disgust.

This paradoxical relationship can be understood through dual-process theories, which describe cognition as an interplay between evolutionary old type I (intuitive, effortless, low-level) and evolutionary recent type II (analytic, effortful, high-level) processes. Over evolutionary time, new cognitive functions may evolve to serve similar purposes as older ones but with higher-order flexibility, thus driving the same brain to produce two different responses toward a single stimulus. Consequently, conflicts and paradoxes between type I and type II processes are a recurring theme in dual-process theories (De Neys & Glumicic, 2008; Elimari, 2023; Elimari & Lafargue, 2023a, 2024; Evans, 2007; Evans & Stanovich, 2013; Kahneman, 2011; Barrett & Kurzban, 2006, 2012).

We propose that the pathogen/moral disgust paradox stems from moral disgust’s status as a more evolutionary recent, type II subsystem of the BIS (Curtis et al., 2011; Kelly, 2011; Rozin et al., 2009; Tybur et al., 2009), making it more permeable to cultural influences such as moral values. This dual-process perspective of the BIS extends the typical view that pathogen disgust exerts bottom-up influences on moral cognition, and considers top-down influences of moral disgust on pathogen disgust also. Moral values, shaped through processes

unrelated to disgust, may conflict with the automatic exclusionary responses of pathogen disgust, facilitating opposing moral outputs that influence behavioral outcome.

Future research should explore how cognitive dissonance between pathogen and moral disgusts is resolved. Conflict resolution may either favor moral disgust (effortful top-down control aligned with moral values) or pathogen disgust (instinctive disease-avoidance impulses, with potential post-hoc rationalization through adjustments in moral beliefs). As shown in prior studies (Elimari & Lafargue, 2023a, 2024), neural correlates of conflict (e.g., error-related negativity, Falkenstein et al., 1991; Gehring et al., 1993, 2018), can be used as indexes of cognitive dissonance and illuminate these dual-process dynamics, providing insights into pathogen/moral conflicts and how the subsequent cognitive dissonance is resolved as a function of individual traits.

These individual traits are themselves of grand importance. Moral disgust is likely influenced by a range of factors, from moral values and political leanings to empathy, religiosity, and other social emotions (e.g., compassion, gratitude, trust, anger, envy). Together, these influences can either reinforce or contradict the exclusionary impulses of pathogen disgust. The potential of moral disgust to act as a top-down regulator of the BIS is a promising area for future research into strategies that leverage the BIS own mechanisms to regulate its more automatic, exclusionary outputs. For instance, future research should explore which moral values are most effective at curbing BIS' exclusionary tendencies. Also, psychological interventions focused on emotional regulation hold promises. For instance, fostering emotion identification and comprehension in children has been shown to enhance emotional insight and regulation (Denham, 2007; Trentacosta & Fine, 2010; Vy et al., 2024), providing a baseline for adapted educational programs preventing disgust-driven prejudices to take root. Additionally, contemplative sciences offer methods for reshaping both social interactions and internal experiences. Meditation-based practices, in particular, have proven effective in facilitating self-awareness and nurturing other-oriented emotions like openness, compassion, trust, and connectedness (Dambrun & Ricard, 2011; Dambrun et al., 2024; Dahl et al., 2015; De Oliveira et al., 2024; Gilbert et al., 2024; Stinus & Berjot, 2024; Stinus et al., 2024a, 2024b).

The need for a xenodyskheria update to outgroup prejudice modelization

The COVID crisis has highlighted scientists' tendency to primarily frame emotional responses to pandemics in terms of stress, anxiety, and fear, as reflected in the names of the most cited measures of affective responses to pandemics: Lee's (2020) *Coronavirus Anxiety scale* has been cited 2188 times as of this writing, Taylor et al.'s (2020) *COVID Stress Scales* 1461 times, and Ahorsu et al.'s (2020) *Fear of COVID scale* a notable 5832 times. Comparatively, disgust received significantly less attention: the *Three Domains of Disgust* (Tybur et al., 2009) and *Perceived Vulnerability to Disease* (Duncan et al., 2009) scales have garnered only 280 and 571 COVID-related citations, respectively. These disparities illustrate the prevailing view of emotional responses to pandemics as one big batch of undifferentiated negative feelings rather than a constellation of diverse, domain-specific responses adaptively mitigating distinct fitness threats.

This oversight extends to the research on outgroup prejudice, which lies on a series of assumptions (more or less implicit) that xenophobia and racism exclusively stems from anxiety and stress (Amodio, 2009; Bijleveld et al., 2012; Dhont et al., 2011; Guglielmi, 1999; Page-Gould et al., 2010; Paolini et al., 2004, 2016; Stephan & Stephan, 1985; Trawalter et al., 2012). This perspective is evident in both the phraseology (e.g., "*intergroup anxiety*" or terms ending with the suffix *-phobos*) and the measures employed. For instance, the widely used

Intergroup Anxiety Scale (Stephan & Stephan, 1985) measures outgroup prejudice by assessing 12 distinct feelings (e.g., apprehension, uncertainty, worry, anxiety, threat), but conspicuously omits disgust.

Our results, along with existing research on behavioral immunity, warrant a general updating of the conventional perspective on outgroup prejudice. Though it would be reductive to attribute all forms of discrimination to disgust mechanisms, many aspects of intergroup relations should be construed as manifestations of behavioral immunity. Consequently, social policies designed to reduce prejudice must address disgust as a key driver. Going even further, we argue that societies should remain vigilant about cultural narratives that repeatedly associate certain groups with cues that trigger the BIS. Historical precedents suggest that pre-genocidal periods often involve such associations, leading to evaluative conditioning effects that harness behavioral immunity into eliciting abhorrence and dehumanization (see Lateiner & Spatharas, 2016, for a discussion). For instance, Nazi propaganda dehumanized Jewish people by comparing them to disease-causing agents (e.g., *parasites, rats, vermin, poison*) or outright epidemics (e.g., *plague, pestilence*, Landry et al., 2021, 2022; Musolff, 2007; Neilsen, 2015; Savage, 2007). Earlier in history, Jewish people were routinely accused of poisoning wells right before pogroms (Finley & Koyama, 2018). In his essay “*En Congolie*”, Edmond Picard, justified overworking Congolese to death by comparing them to “*beasts of burden [...], dusty and sweaty, insects spreading out across mountains and valleys*”. In the months prior to the Rwandese genocide, several messages broadcasted on *Radio-Télévision Libre des Mille Collines* frequently referred to the Tutsi as “*Inyenzi*”, or cockroaches. This suggests that xenodyskheria may be a key gateway to intergroup dehumanization, potentially leading to the inhumane acts repeatedly witnessed in human history. If so, a deeper understanding of xenodyskheria is more crucial than ever.

Author contributions

Nassim Elimari: Conceptualization, Methodology, Formal Analysis, Investigation, Visualization, Writing – Original Draft. **Gilles Lafargue:** Conceptualization, Writing – Original Draft, Visualization, Supervision, Project Administration.

Declaration of Interests

The authors declare no competing interests.

Funding

This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

References

- Ackerman, J. M., Hill, S. E., & Murray, D. R. (2018). The behavioral immune system: Current concerns and future directions. *Social and Personality Psychology Compass*, 12(2), e12371. <https://doi.org/10.1111/spc3.12371>
- Ahorsu, D. K., Lin, C.-Y., Imani, V., Saffari, M., Griffiths, M. D., & Pakpour, A. H. (2020). The fear of COVID-19 scale: Development and initial validation. *International Journal of Mental Health and Addiction*, 1–9. <https://doi.org/10.1007/s11469-020-00270-8>

- Amodio, D. M. (2009). Intergroup anxiety effects on the control of racial stereotypes: A psychoneuroendocrine analysis. *Journal of Experimental Social Psychology*, 45(1), 60–67. <https://doi.org/10.1016/j.jesp.2008.08.009>
- Anderson, M. L. (2016). Précis of After Phrenology: Neural Reuse and the Interactive Brain. *Behavioral and Brain Sciences*, 39, e120. <https://doi.org/10.1017/S0140525X15000631>
- Anderson, M. L. (2021). *After phrenology: Neural reuse and the interactive brain*. MIT Press.
- Anderson, W. (2014). Racial conceptions in the Global South. *Isis*, 105(4), 782–792.
- Badcock, P. B., Friston, K. J., & Ramstead, M. J. (2019). The hierarchically mechanistic mind: A free-energy formulation of the human psyche. *Physics of Life Reviews*, 31, 104–121. <https://doi.org/10.1016/j.plrev.2018.10.002>
- Badcock, P. B., Friston, K. J., Ramstead, M. J., Ploeger, A., & Hohwy, J. (2019). The hierarchically mechanistic mind: an evolutionary systems theory of the human brain, cognition, and behavior. *Cognitive, Affective, & Behavioral Neuroscience*, 19(6), 1319–1351. <https://doi.org/10.3758/s13415-019-00721-3>
- Barreiro, L. B., & Quintana-Murci, L. (2010). From evolutionary genetics to human immunology: How selection shapes host defence genes. *Nature Reviews Genetics*, 11(1), 17–30. <https://doi.org/10.1038/nrg2698>
- Barrett, H. C., & Kurzban, R. (2006). Modularity in cognition: Framing the debate. *Psychological Review*, 113(3), 628.
- Barrett, H. C., & Kurzban, R. (2012). What are the functions of System 2 modules? A reply to Chiappe and Gardner. *Theory & Psychology*, 22(5), 683–688. <https://doi.org/10.1177/0959354312455469>
- Bijleveld, E., Scheepers, D., & Ellemers, N. (2012). The cortisol response to anticipated intergroup interactions predicts self-reported prejudice. *PLoS One*, 7(3), e33681. <https://doi.org/10.1371/journal.pone.0033681>
- Binder, J., Zagefka, H., Brown, R., Funke, F., Kessler, T., Mummendey, A., Maquil, A., Demoulin, S., & Leyens, J.-P. (2009). Does contact reduce prejudice or does prejudice reduce contact? A longitudinal test of the contact hypothesis among majority and minority groups in three European countries. *Journal of Personality and Social Psychology*, 96(4), 843.
- Bogardus, E. S. (1933). A social distance scale. *Sociology & Social Research*.
- Bonin, P., Thiebaut, G., Witt, A., & Méot, A. (2019). Contamination is “good” for your memory! Further evidence for the adaptive view of memory. *Evolutionary Psychological Science*, 5, 300–316. <https://doi.org/10.1007/s40806-019-00188-y>
- Bressan, P. (2021). Strangers look sicker (with implications in times of COVID-19). *BioEssays*, 43(3), 2000158. <https://doi.org/10.1002/bies.202000158>
- Bressan, P. (2023). Racism is not about “race.” *Scientific Reports*, 13(1), 22339. <https://doi.org/10.1038/s41598-023-47653-0>
- Cairns, J. (1997). *Matters of life and death: perspectives on public health, molecular biology, cancer, and the prospects for the human race*. Princeton University Press.

- Calhoun, V. D., Miller, R., Pearlson, G., & Adalı, T. (2014). The Chronnectome: Time-Varying Connectivity Networks as the Next Frontier in fMRI Data Discovery. *Neuron*, 84(2), 262–274. <https://doi.org/10.1016/j.neuron.2014.10.015>
- Calvillo, D. P., Ross, B. J., Garcia, R. J. B., Smelter, T. J., & Rutchick, A. M. (2020). Political Ideology Predicts Perceptions of the Threat of COVID-19 (and Susceptibility to Fake News About It). *Social Psychological and Personality Science*, 11(8), 1119–1128. <https://doi.org/10.1177/1948550620940539>
- Casanova, J.-L., & Abel, L. (2005). Inborn errors of immunity to infection: The rule rather than the exception. *The Journal of Experimental Medicine*, 202(2), 197–201. <https://doi.org/10.1084/jem.20050854>
- Chapman, H. A., & Anderson, A. K. (2012). Understanding disgust. *Annals of the New York Academy of Sciences*, 1251(1), 62–76. <https://doi.org/10.1111/j.1749-6632.2011.06369.x>
- Chapman, H. A., & Anderson, A. K. (2013). Things rank and gross in nature: A review and synthesis of moral disgust. *Psychological Bulletin*, 139(2), 300.
- Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: Evidence for the oral origins of moral disgust. *Science*, 323(5918), 1222–1226. <https://doi.org/10.1126/science.1165565>
- Chu, X., Zhao, Y., Li, X., Yang, S., & Lei, Y. (2024). The sense of responsibility and bystanders' prosocial behavior in cyberbullying: The mediating role of compassion and the moderating roles of moral outrage and moral disgust. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, 18(3). <https://doi.org/10.5817/CP2024-3-8>
- Curtis, R., Groarke, A., Coughlan, R., & Gsel, A. (2004). The influence of disease severity, perceived stress, social support and coping in patients with chronic illness: A 1 year follow up. *Psychology, Health & Medicine*, 9(4), 456–475. <https://doi.org/10.1080/1354850042000267058>
- Curtis, V., De Barra, M., & Auger, R. (2011). Disgust as an adaptive system for disease avoidance behaviour. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1563), 389–401. <https://doi.org/10.1098/rstb.2010.0117>
- Dahl, C. J., Lutz, A., & Davidson, R. J. (2015). Reconstructing and deconstructing the self: Cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences*, 19(9), 515–523. <https://doi.org/10.1016/j.tics.2015.07.001>
- Dambrun, M., Hanley, A., Garland, E., De Oliveira, P., Stinus, C., Pellerin, N., ... & Juneau, C. (2024). The effect of a short mindfulness meditation practice on positive mental health: Self-transcendence as a mediating process. *International journal of wellbeing*, 14(3), 1-22. <https://dx.doi.org/10.5502/ijw.v14i3.3635>
- Dambrun, M., & Ricard, M. (2011). Self-centeredness and selflessness: A theory of self-based psychological functioning and its consequences for happiness. *Review of General Psychology*, 15(2), 138–157. <https://doi.org/10.1037/a0023059>
- De Neys, W., & Glumicic, T. (2008). Conflict monitoring in dual process theories of thinking. *Cognition*, 106(3), 1248–1299. <https://doi.org/10.1016/j.cognition.2007.06.002>

- De Oliveira, P., Juneau, C., Stinus, C., Corman, M., Michelli, N., Pellerin, N., ... & Dambrun, M. (2024). Cultivating self-transcendence through meditation practice: A test of the role of meta-awareness,(dis) identification and non-reactivity. *Psychological Reports*, 00332941241246469. <https://doi.org/10.1177/00332941241246469>
- Delanty, G. (2008). Fear of others: Social exclusion and the European crisis of solidarity. *Social Policy & Administration*, 42(6), 676–690. <https://doi.org/10.1111/j.1467-9515.2008.00631.x>
- Denham, S. A. (2007). Dealing with feelings: How children negotiate the worlds of emotions and social relationships. *Cognition, Creier, Comportament/Cognition, Brain, Behavior*, 11(1).
- Dhont, K., Roets, A., & Van Hiel, A. (2011). Opening closed minds: The combined effects of intergroup contact and need for closure on prejudice. *Personality and Social Psychology Bulletin*, 37(4), 514–528. <https://doi.org/10.1177/0146167211399101>
- Duncan, L. A., Schaller, M., & Park, J. H. (2009). Perceived vulnerability to disease: Development and validation of a 15-item self-report instrument. *Personality and Individual Differences*, 47(6), 541–546. <https://doi.org/10.1016/j.paid.2009.05.001>
- Elimari, N. (2023). *Approches duelle et évolutive de la neurocognition: nature et corrélats neuraux des processus de régulation entre instincts et cognition de haut-niveau* (Doctoral dissertation, Reims).
- Elimari, N., & Lafargue, G. (2020). Network neuroscience and the adapted mind: rethinking the role of network theories in evolutionary psychology. *Frontiers in psychology*, 11, 545632. <https://doi.org/10.3389/fpsyg.2020.545632>
- Elimari, N., & Lafargue, G. (2023a). Neural correlates of performance monitoring vary as a function of competition between automatic and controlled processes: An ERP study. *Consciousness and Cognition*, 110, 103505. <https://doi.org/10.1016/j.concog.2023.103505>
- Elimari, N., & Lafargue, G. (2023b). Qu'est-ce que la psychologie évolutive ? Cognition et comportements à la lumière de l'évolution. *L'Année Psychologique*, 123(1), 173-214. <https://doi.org/10.3917/anpsy1.231.0173>
- Elimari, N., & Lafargue, G. (2024). Two social minds in one brain? error-related negativity provides evidence for parallel processing pathways during social evaluation. *Cognition and Emotion*, 38(1), 90-102. <https://doi.org/10.1080/02699931.2023.2270200>
- Esses, V. M., Dovidio, J. F., Jackson, L. M., & Armstrong, T. L. (2001). The immigration dilemma: The role of perceived group competition, ethnic prejudice, and national identity. *Journal of Social Issues*, 57(3), 389–412. <https://doi.org/10.1111/0022-4537.00220>
- Evans, J. S. B. (2007). On the resolution of conflict in dual process theories of reasoning. *Thinking & Reasoning*, 13(4), 321–339. <https://doi.org/10.1080/13546780601008825>
- Evans, J. S. B., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science*, 8(3), 223–241. <https://doi.org/10.1177/1745691612460685>
- Falkenstein, M., Hohnsbein, J., Hoormann, J., & Blanke, L. (1991). Effects of crossmodal divided attention on late ERP components. II. Error processing in choice reaction tasks. *Electroencephalography and Clinical Neurophysiology*, 78(6), 447–455. [https://doi.org/10.1016/0013-4694\(91\)90062-9](https://doi.org/10.1016/0013-4694(91)90062-9)

- Fan, L., Tybur, J. M., & Van Lange, P. A. (2024). Salience of infectious diseases did not increase xenophobia during the COVID-19 pandemic. *Evolutionary Human Sciences*, 6, e34. <https://doi.org/10.1017/ehs.2024.28>
- Faulkner, J., Schaller, M., Park, J. H., & Duncan, L. A. (2004). Evolved disease-avoidance mechanisms and contemporary xenophobic attitudes. *Group Processes & Intergroup Relations*, 7(4), 333–353. <https://doi.org/10.1177/1368430204046142>
- Fessler, D., & Navarrete, C. D. (2003). Meat is good to taboo: Dietary proscriptions as a product of the interaction of psychological mechanisms and social processes. *Journal of Cognition and Culture*, 3(1), 1–40. <https://doi.org/10.1163/156853703321598563>
- Fincher, C. L., & Thornhill, R. (2012). Parasite-stress promotes in-group assortative sociality: The cases of strong family ties and heightened religiosity. *Behavioral and Brain Sciences*, 35(2), 61–79. <https://doi.org/10.1017/S0140525X11000021>
- Finley, T., & Koyama, M. (2018). Plague, politics, and pogroms: The Black Death, the rule of law, and the persecution of Jews in the Holy Roman Empire. *The Journal of Law and Economics*, 61(2), 253–277. <https://doi.org/10.1086/699016>
- Fisher, N. (2016). Demosthenes and the use of disgust. In D. Lateiner & D. Spatharas (Eds.), *The ancient emotion of disgust* (pp. 103–124). Oxford University Press.
- Gehring, W. J., Goss, B., Coles, M. G. H., Meyer, D. E., & Donchin, E. (1993). A Neural System for Error Detection and Compensation. *Psychological Science*, 4(6), 385–390. <https://doi.org/10.1111/j.1467-9280.1993.tb00586.x>
- Gehring, W. J., Goss, B., Coles, M. G., Meyer, D. E., & Donchin, E. (2018). The error-related negativity. *Perspectives on Psychological Science*, 13(2), 200–204. <https://doi.org/10.1177/1745691617715310>
- Gilbert, P., Huxter, M., & Choden. (2024). Exploration of evolution-informed compassion-focused therapy and Buddhist approaches to insight meditation: A three-way exploration. *Mindfulness*, 15(5), 1014–1037. <https://doi.org/10.1007/s12671-023-02141-4>
- Greenberg, J., Pyszczynski, T., & Solomon, S. (1986). The causes and consequences of a need for self-esteem: A terror management theory. In *Public self and private self* (pp. 189–212). Springer. https://doi.org/10.1007/978-1-4613-9564-5_10
- Gudykunst, W. B. (1995). The uncertainty reduction and anxiety-uncertainty reduction theories of Berger, Gudykunst, and associates. *Watershed Research Traditions in Human Communication Theory*, 67–100.
- Guglielmi, R. S. (1999). Psychophysiological assessment of prejudice: Past research, current status, and future directions. *Personality and Social Psychology Review*, 3(2), 123–157. https://doi.org/10.1207/s15327957pspr0302_3
- Hart, B. L. (1988). Biological basis of the behavior of sick animals. *Neuroscience & Biobehavioral Reviews*, 12(2), 123–137. [https://doi.org/10.1016/S0149-7634\(88\)80004-6](https://doi.org/10.1016/S0149-7634(88)80004-6)
- Hart, B. L. (1990). Behavioral adaptations to pathogens and parasites: Five strategies. *Neuroscience & Biobehavioral Reviews*, 14(3), 273–294. [https://doi.org/10.1016/S0149-7634\(05\)80038-7](https://doi.org/10.1016/S0149-7634(05)80038-7)

Hart, B. L. (2011). Behavioural defences in animals against pathogens and parasites: Parallels with the pillars of medicine in humans. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1583), 3406–3417. <https://doi.org/10.1098/rstb.2011.0092>

Herbet, G., & Duffau, H. (2020). Revisiting the functional anatomy of the human brain: Toward a meta-networking theory of cerebral functions. *Physiological Reviews*, 100(3), 1181–1228. <https://doi.org/10.1152/physrev.00033.2019>

Hlay, J. K., Albert, G., Batres, C., Richardson, G., Placek, C., Arnocky, S., ... & Hodges-Simeon, C. R. (2021). The evolution of disgust for pathogen detection and avoidance. *Scientific Reports*, 11(1), 13468. <https://doi.org/10.1038/s41598-021-91712-3>

Hromatko, I., Grus, A., & Kolderaj, G. (2021). Do islanders have a more reactive behavioral immune system? Social cognitions and preferred interpersonal distances during the COVID-19 pandemic. *Frontiers in Psychology*, 12, 647586. <https://doi.org/10.3389/fpsyg.2021.647586>

Hromatko, I., Tonković, M., & Vranic, A. (2021). Trust in science, perceived vulnerability to disease, and adherence to pharmacological and non-pharmacological COVID-19 recommendations. *Frontiers in Psychology*, 12, 664554. <https://doi.org/10.3389/fpsyg.2021.664554>

Huang, J. Y., Sedlovskaya, A., Ackerman, J. M., & Bargh, J. A. (2011). Immunizing against prejudice: Effects of disease protection on attitudes toward out-groups. *Psychological Science*, 22(12), 1550–1556. <https://doi.org/10.1177/0956797611417261>

Kahneman, D. (2011). *Thinking, fast and slow* (1st ed). Farrar, Straus and Giroux.

Kelly, D. (2011). *Yuck!: The nature and moral significance of disgust*. MIT press.

Kopell, N. J., Gritton, H. J., Whittington, M. A., & Kramer, M. A. (2014). Beyond the connectome: The dynamo. *Neuron*, 83(6), 1319–1328. <https://doi.org/10.1016/j.neuron.2014.08.016>

Kramer, P., & Bressan, P. (2021). Infection threat shapes our social instincts. *Behavioral Ecology and Sociobiology*, 75(3), 47. <https://doi.org/10.1007/s00265-021-02975-9>

Landry, A. P., Ihm, E., & Schooler, J. W. (2022). Filthy animals: Integrating the behavioral immune system and disgust into a model of prophylactic dehumanization. *Evolutionary psychological science*, 8(2), 120–133. <https://doi.org/10.1007/s40806-021-00296-8>

Landry, A. P., Orr, R. I., & Mere, K. (2022). Dehumanization and mass violence: A study of mental state language in Nazi propaganda (1927–1945). *PLoS one*, 17(11), e0274957.

Lateiner, D., & Spatharas, D. (2016). *The ancient emotion of disgust*. Oxford University Press.

Lee, S. A. (2020). Coronavirus Anxiety Scale: A brief mental health screener for COVID-19 related anxiety. *Death Studies*, 44(7), 393–401. <https://doi.org/10.1080/07481187.2020.1748481>

Lieberman, D., & Patrick, C. (2014). Are the behavioral immune system and pathogen disgust identical? *Evolutionary Behavioral Sciences*, 8(4), 244. <https://psycnet.apa.org/doi/10.1037/ebs0000018>

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, 33(3), 335–343.

Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. *Behavior Research Methods*, 47, 1122–1135. <https://doi.org/10.3758/s13428-014-0532-5>

Mayda, A. M. (2006). Who is against immigration? A cross-country investigation of individual attitudes toward immigrants. *The Review of Economics and Statistics*, 88(3), 510–530. <https://doi.org/10.1162/rest.88.3.510>

Miłkowska, K., Galbarczyk, A., Mijas, M., & Jasienska, G. (2021). Disgust sensitivity among women during the COVID-19 outbreak. *Frontiers in Psychology*, 12, 622634. <https://doi.org/10.3389/fpsyg.2021.622634>

Moll, J., Zahn, R., de Oliveira-Souza, R., Krueger, F., & Grafman, J. (2005). The neural basis of human moral cognition. *Nature Reviews Neuroscience*, 6(10), 799–809. <https://doi.org/10.1038/nrn1768>

Motta, M., Stecula, D., & Farhart, C. (2020). How Right-Leaning Media Coverage of COVID-19 Facilitated the Spread of Misinformation in the Early Stages of the Pandemic in the U.S. *Canadian Journal of Political Science/Revue Canadienne de Science Politique*, 53(2), 335–342. <https://doi.org/10.1017/S0008423920000396>

Murray, D. R., & Schaller, M. (2012). Threat (s) and conformity deconstructed: Perceived threat of infectious disease and its implications for conformist attitudes and behavior. *European Journal of Social Psychology*, 42(2), 180–188. <https://doi.org/10.1002/ejsp.863>

Musolf, A. (2007) What role do metaphors play in racial prejudice? The function of antisemitic imagery in Hitler's *Mein Kampf*. *Patterns of Prejudice* 41, 21–43.

Navarrete, C. D., & Fessler, D. M. (2006). Disease avoidance and ethnocentrism: The effects of disease vulnerability and disgust sensitivity on intergroup attitudes. *Evolution and Human Behavior*, 27(4), 270–282. <https://doi.org/10.1016/j.evolhumbehav.2005.12.001>

Navarrete, C. D., Kurzban, R., Fessler, D. M., & Kirkpatrick, L. A. (2004). Anxiety and intergroup bias: Terror management or coalitional psychology? *Group Processes & Intergroup Relations*, 7(4), 370–397. <https://doi.org/10.1177/1368430204046144>

Neilsen, R. S. (2015). 'Toxification' as a More Precise Early Warning Sign for Genocide Than Dehumanization? An Emerging Research Agenda. *Genocide Studies and Prevention*, 9(1), 83–95. <http://dx.doi.org/10.5038/1911-9933.9.1.1277>

Olivera-La Rosa, A., Chuquichambi, E. G., & Ingram, G. P. (2020). Keep your (social) distance: Pathogen concerns and social perception in the time of COVID-19. *Personality and Individual Differences*, 166, 110200. <https://doi.org/10.1016/j.paid.2020.110200>

Oriol, X., Miranda, R., & Amutio, A. (2023). Dispositional and situational moral emotions, bullying and prosocial behavior in adolescence. *Current Psychology*, 42(13), 11115–11132. <https://doi.org/10.1007/s12144-021-02396-x>

Page-Gould, E., Mendes, W. B., & Major, B. (2010). Intergroup contact facilitates physiological recovery following stressful intergroup interactions. *Journal of Experimental Social Psychology*, 46(5), 854–858. <https://doi.org/10.1016/j.jesp.2010.04.006>

- Paolini, S., Harris, N. C., & Griffin, A. S. (2016). Learning anxiety in interactions with the outgroup: Towards a learning model of anxiety and stress in intergroup contact. *Group Processes & Intergroup Relations*, 19(3), 275–313. <https://doi.org/10.1177/1368430215572265>
- Paolini, S., Hewstone, M., Cairns, E., & Voci, A. (2004). Effects of direct and indirect cross-group friendships on judgments of Catholics and Protestants in Northern Ireland: The mediating role of an anxiety-reduction mechanism. *Personality and Social Psychology Bulletin*, 30(6), 770–786. <https://doi.org/10.1177/0146167203262848>
- Pettigrew, T. F., Tropp, L. R., Wagner, U., & Christ, O. (2011). Recent advances in intergroup contact theory. *International Journal of Intercultural Relations*, 35(3), 271–280. <https://doi.org/10.1016/j.ijintrel.2011.03.001>
- Rozin, P., Haidt, J., & Fincher, K. (2009). From oral to moral. *Science*, 323(5918), 1179–1180. <https://doi.org/10.1126/science.1170492>
- Rozin, P., Haidt, J., & McCauley, C. R. (2008). *Disgust*. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 757–776). The Guilford Press.
- Savage, R. (2007). “Disease incarnate”: Biopolitical discourse and genocidal dehumanisation in the age of modernity. *Journal of Historical Sociology*, 20(3), 404–440. <https://doi.org/10.1111/j.1467-6443.2007.00315.x>
- Schaller, M. (2006). Parasites, Behavioral Defenses, and the Social Psychological Mechanisms Through Which Cultures Are Evoked. *Psychological Inquiry*, 17(2), 96–137.
- Schaller, M. (2014). When and how disgust is and is not implicated in the behavioral immune system. *Evolutionary Behavioral Sciences*, 8(4), 251. <https://psycnet.apa.org/doi/10.1037/ebs0000019>
- Schaller, M., & Duncan, L. A. (2016). The behavioral immune system. *The Handbook of Evolutionary Psychology*, 1, 206–224.
- Schaller, M., & Park, J. H. (2011). The behavioral immune system (and why it matters). *Current Directions in Psychological Science*, 20(2), 99–103. <https://doi.org/10.1177/0963721411402596>
- Schnall, S., Benton, J., & Harvey, S. (2008). With a clean conscience: Cleanliness reduces the severity of moral judgments. *Psychological Science*, 19(12), 1219–1222. <https://doi.org/10.1111/j.1467-9280.2008.02227.x>
- Schwambergová, D., Kaňková, Š., Třebická Fialová, J., Hlaváčová, J., & Havlíček, J. (2023). Pandemic elevates sensitivity to moral disgust but not pathogen disgust. *Scientific Reports*, 13(1), 8206. <https://doi.org/10.1038/s41598-023-35375-2>
- Sorokowski, P., Groyecka, A., Kowal, M., Sorokowska, A., Białek, M., Lebeda, I., Dobrowolska, M., Zdybek, P., & Karwowski, M. (2020). Can information about pandemics increase negative attitudes toward foreign groups? A case of COVID-19 outbreak. *Sustainability*, 12(12), 4912. <https://doi.org/10.3390/su12124912>
- Stephan, W. G., & Stephan, C. W. (1985). Intergroup anxiety. *Journal of Social Issues*, 41(3), 157–175.
- Stephan, W. G., & Stephan, C. W. (2013). An integrated threat theory of prejudice. In *Reducing prejudice and discrimination* (pp. 23–45). Psychology Press.

Stephan, W. G., Stephan, C. W., & Gudykunst, W. B. (1999). Anxiety in intergroup relations: A comparison of anxiety/uncertainty management theory and integrated threat theory. *International Journal of Intercultural Relations*, 23(4), 613–628. [https://doi.org/10.1016/S0147-1767\(99\)00012-7](https://doi.org/10.1016/S0147-1767(99)00012-7)

Stephan, W. G., Ybarra, O., & Rios, K. (2015). Intergroup threat theory. In *Handbook of prejudice, stereotyping, and discrimination* (pp. 255–278). Psychology Press.

Stinus, C., & Berjot, S. (2024). Threat to the self at the heart of depression: Mediating role and depressogenic prism hypothesis: Amenaza del yo en el núcleo de la depresión: Papel mediador e hipótesis del prisma depresógeno. *Revista de Psicopatología y Psicología Clínica*, 29(3), Article 3. <https://doi.org/10.5944/rppc.41391>

Stinus, C., Elimari, N., & Berjot, S. (2024). Reconnecting with our human nature: A holistic approach to addressing social and environmental crises. *European Journal of Consumer Law*, 3, 485–500.

Stinus, C., Shankland, R., & Berjot, S. (2024). Connectedness to humanity and connectedness to nature as a leverage point for eco and socio-responsible consumption. *Current Psychology*. <https://doi.org/10.1007/s12144-024-06621-1>

Taylor, S., Landry, C. A., Paluszek, M. M., Fergus, T. A., McKay, D., & Asmundson, G. J. (2020). Development and initial validation of the COVID Stress Scales. *Journal of Anxiety Disorders*, 72, 102232. <https://doi.org/10.1016/j.janxdis.2020.102232>

Terrizzi Jr, J. A., Shook, N. J., & McDaniel, M. A. (2013). The behavioral immune system and social conservatism: A meta-analysis. *Evolution and Human Behavior*, 34(2), 99–108. <https://doi.org/10.1016/j.evolhumbehav.2012.10.003>

Thiebaut, G., Méot, A., Prokop, P., & Bonin, P. (2024). Why are we Afraid of Holes? A Brief Review of Trypophobia Through an Adaptationist Lens. *Evolutionary Psychological Science*, 1–13. <https://doi.org/10.1007/s40806-024-00396-1>

Thiebaut, G., Méot, A., Witt, A., Prokop, P., & Bonin, P. (2021). “Touch me if you can!”: Individual differences in disease avoidance and social touch. *Evolutionary Psychology*, 19(4), 14747049211056159. <https://doi.org/10.1177/14747049211056159>

Thiebaut, G., Méot, A., Witt, A., Prokop, P., & Bonin, P. (2023). Pseudo-contamination and memory: Is there a memory advantage for objects touched by “morphologically deviant people”? *Evolutionary Psychological Science*, 9(2), 121–134. <https://doi.org/10.1007/s40806-022-00345-w>

Thornhill, R., Fincher, C. L., & Aran, D. (2009). Parasites, democratization, and the liberalization of values across contemporary countries. *Biological Reviews*, 84(1), 113–131. <https://doi.org/10.1111/j.1469-185X.2008.00062.x>

Trawalter, S., Adam, E. K., Chase-Lansdale, P. L., & Richeson, J. A. (2012). Concerns about appearing prejudiced get under the skin: Stress responses to interracial contact in the moment and across time. *Journal of Experimental Social Psychology*, 48(3), 682–693. <https://doi.org/10.1016/j.jesp.2011.12.003>

Trentacosta, C. J., & Fine, S. E. (2010). Emotion knowledge, social competence, and behavior problems in childhood and adolescence: A meta-analytic review. *Social Development*, 19(1), 1–29. <https://doi.org/10.1111/j.1467-9507.2009.00543.x>

- Tybur, J. M., Inbar, Y., Aarøe, L., Barclay, P., Barlow, F. K., De Barra, M., Becker, D. V., Borovoi, L., Choi, I., & Choi, J. A. (2016). Parasite stress and pathogen avoidance relate to distinct dimensions of political ideology across 30 nations. *Proceedings of the National Academy of Sciences*, 113(44), 12408–12413. <https://doi.org/10.1073/pnas.1607398113>
- Tybur, J. M., Lieberman, D., & Griskevicius, V. (2009). Microbes, mating, and morality: Individual differences in three functional domains of disgust. *Journal of Personality and Social Psychology*, 97(1), 103.
- Tybur, J. M., Lieberman, D., Kurzban, R., & DeScioli, P. (2013). Disgust: Evolved function and structure. *Psychological Review*, 120(1), 65.
- van Leeuwen, F., & Petersen, M. B. (2018). The behavioral immune system is designed to avoid infected individuals, not outgroups. *Evolution and Human Behavior*, 39(2), 226–234. <https://doi.org/10.1016/j.evolhumbehav.2017.12.003>
- Vanneman, R. D., & Pettigrew, T. F. (1972). Race and relative deprivation in the urban United States. *Race*, 13(4), 461–486. <https://doi.org/10.1177/030639687201300404>
- Vy, M., Ferrara, S., Dollion, N., & Declercq, C. (2024). Relationship between emotion comprehension, vocabulary, and verbal working memory in intellectual developmental disorders: Involvement of verbal reasoning skills. *Cognition and Emotion*, 1–9. <https://doi.org/10.1080/02699931.2024.2372382>
- Weaver, C. N. (2008). Social distance as a measure of prejudice among ethnic groups in the United States. *Journal of Applied Social Psychology*, 38(3), 779–795. <https://doi.org/10.1111/j.1559-1816.2007.00326.x>
- Wheaton, M. G., Prikhidko, A., & Messner, G. R. (2021). Is fear of COVID-19 contagious? The effects of emotion contagion and social media use on anxiety in response to the coronavirus pandemic. *Frontiers in Psychology*, 11, 567379. <https://doi.org/10.3389/fpsyg.2020.567379>
- Ying, X., Luo, J., Chiu, C., Wu, Y., Xu, Y., & Fan, J. (2018). Functional dissociation of the posterior and anterior insula in moral disgust. *Frontiers in Psychology*, 9, 860. <https://doi.org/10.3389/fpsyg.2018.00860>
- Zhong, C.-B., & Liljenquist, K. (2006). Washing away your sins: Threatened morality and physical cleansing. *Science*, 313(5792), 1451–1452. <https://doi.org/10.1126/science.1130726>