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# People Use Psychological Cues to Detect Physical Disease From Faces

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## Abstract

Previous theoretical work has suggested that people can accurately perceive disease from others' appearances and behaviors. However, much of that research has examined diseases with relatively obvious symptoms (e.g., scars, obesity, blemishes, sneezing). Here, we examined whether people similarly detect diseases that do not exhibit such visible physical cues (i.e., sexually transmitted diseases). We found that people could indeed identify individuals infected with sexually transmitted diseases significantly better than chance from photos of their faces. Perceptions of the targets' affective expression and socioeconomic status mediated participants' accuracy. Finally, increasing participants' contamination fears improved their sensitivity to disease cues. These data therefore suggest that people may use subtle and indirect psychological markers to detect some physical diseases from appearance.

## Keywords

accuracy, disease, face perception, health, social perception

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Across the globe and throughout human evolution, the battle against infectious disease ranks among life's greatest challenges. Indeed, infectious illness represents one of the most destructive enemies that humans encounter on a routine basis (Mathers, Fat, & Boerma, 2008). The diagnosis and prevention of disease are therefore central to human survival (Re & Rule, 2016). People thus employ a multitude of cognitive and behavioral strategies to avoid diseases. Individuals must be able to detect disease to avoid it, however. Although the psychological literature is replete with examples demonstrating that people can deftly identify disease potential from very obvious cues (such as blemishes, obesity, sneezing, and skin coloration; Kleck & Strenta, 1985; Re & Rule, 2016; Schaller, 2008; Schaller & Park, 2011), it remains unclear whether people can detect disease without such obvious markers. We therefore examined whether individuals could successfully identify diseases absent visible physical symptoms by focusing on perceptions of psychological cues to HIV and herpes from an interpersonal accuracy perspective.

## Perception for Survival

Upon entering a new environment, individuals immediately make inferences about others based on their physical characteristics (Zebrowitz, 1997). Ecological theories suggest that human perception serves a survival-enhancing purpose (Gibson, 1986/2014; McArthur & Baron, 1983): People evaluate others to help them decide whether to approach

(as in potential mates) or avoid (as in threatening rivals) another person (Buss & Schmitt, 1993; Schaller, 2008). Although immediate dangers may capture one's attention with priority (e.g., fear-eliciting stimuli; Öhman & Mineka, 2001), dangers to one's long-term well-being may also pose considerable threat (Schaller, 2008). For example, accurate evaluations of a person's poor health status could prevent social interaction and, consequently, reduce one's chances of infection (Schaller, 2008; Schaller & Park, 2011).

Indeed, people actively gauge others' health to avoid infectious diseases (Schaller & Park, 2011). Although a sneezing friend and an angry dog represent quite different threats, they may nonetheless be similar in their potential levels of harm. Similar to various immediate threats, infectious diseases can thus endanger one's short-term survival and reproductive fitness, and also present long-term dangers to an organism's well-being. Thus, scholars have proposed that humans may have developed a *behavioral immune system* (BIS) to identify cues to the presence of pathogens in the environment (Murray & Schaller, 2015; Schaller & Park, 2011). Data suggest that the BIS may activate from even just anticipating an interaction with a health-threatening target

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(Schaller & Duncan, 2007). This system is therefore thought to (a) infer the presence of disease from relevant signals, (b) engage a response, and subsequently (c) trigger protective behaviors (e.g., avoidance; Miller & Maner, 2011, 2012; Schaller & Park, 2011; Terrizzi, Shook, & McDaniel, 2013).

Because encounters with diseased others increase risks to health (Schaller, 2008), the BIS responds in social interactions. Thus, obese (Park, Schaller, & Crandall, 2007), disabled (Park, Faulkner, & Schaller, 2003), and facially disfigured (Kleck & Strenta, 1985) individuals tend to provoke negative reactions simply because these cues implicitly communicate poor health, meaning that perceivers overgeneralize obvious cues to infer disease (see Miller & Maner, 2012; Zebrowitz & Collins, 1997). In addition, the same stimuli that activate the BIS may also trigger the *biological immune system*, which itself may respond to the mere presentation of photographs of people displaying disease symptoms (Schaller, Miller, Gervais, Yager, & Chen, 2010). Although the existing work aids understanding of why people may avoid individuals displaying disease symptoms and why people may overperceive disease in the environment, very little research has examined whether people may accurately perceive diseases that may lack obvious and visible cues to their presence, such as HIV or herpes. Indeed, given that modern cultural practices (e.g., vaccination) have eliminated the need to detect many overtly visible diseases, the human mind may have developed an ability to detect diseases marked by more subtle manifestations. We explore this possibility in the current work from the perspective of interpersonal accuracy.

## Interpersonal Accuracy

Interpersonal accuracy research has shown that individuals can identify the presence or absence of others' traits from their appearance and behavior (e.g., Re & Rule, 2015). Brunswik (1956) proposed that people accurately perceive others' characteristics when the cues that people use to infer qualities (*cue utility*) match those that correspond to real perceptible differences in the population (*cue validity*). For example, gay men may style their hair more carefully and smile more often than straight men (valid cues), but perceivers may only knowingly evaluate sexual orientation using hairstyle (the used cue) and not smiles (an unused cue; Rule, Ambady, Adams, & Macrae, 2008; Tskhay & Rule, 2015). Similarly, perceivers may also use cues that are not valid; for example, assuming that gay men have larger eyes (Stern, West, Jost, & Rule, 2013) when they do not (Skorska, Geniole, Vrysen, McCormick, & Bogaert, 2015). Thus, people use their implicit beliefs to predict others' traits, which are only sometimes true. Here, we applied a Lens Model (Brunswik, 1956; Nestler & Back, 2013) to understand how people infer disease in other people using psychological cues. In doing so, we focused on several visible features potentially relevant to disease detection.

Although a wide variety of cognitive and behavioral cues could manifest in the appearance of a sick person alongside physical symptoms, we proposed that depressed affect could subtly cue perceivers to sickness due to its comorbidity with chronic illness (Kelly et al., 1993). In addition, given that people with illnesses may feel weaker than healthy people (Centers for Disease Control and Prevention, 2015), we reasoned that perceivers might use inferences of dominance and submissiveness to identify others' disease status (Rule, Adams, Ambady, & Freeman, 2012). Furthermore, because disease prevalence correlates with personal hygiene (Prüss, Kay, Fewtrell, & Bartram, 2002), with conscientiousness and risk-taking (Bogg & Roberts, 2013), and with socioeconomic status (SES; Link & Phelan, 1995), we investigated judgments of each as a potential cue to disease. In other words, we examined these cues as a lens that allows individuals to accurately perceive disease in others from their faces.

## Current Studies

To test whether people can detect the presence of less visible diseases in others, we asked perceivers to categorize the faces of men self-identified as positive and negative for HIV (Study 1A) and herpes (Study 1B), as either sick or healthy. Herpes and HIV present appropriate test cases for examining people's sensitivity to less noticeable diseases, as both are serious chronic diseases that lack obvious physical symptoms when effectively managed (Kumar, 2011; Paauw, Weinrich, Curtis, Carline, & Ramsey, 1995). Following the proposition that the BIS partly functions to accurately identify the presence of disease (Miller & Maner, 2012), and given that individuals can accurately infer physical health (Kramer & Ward, 2010), longevity (Re et al., 2015), and mental illness (Kleiman & Rule, 2013) from the face alone, we predicted that people would discern targets' health status from looking at their faces significantly better than chance. In other words, we examined individuals' ability to accurately perceive disease in Studies 1A and 1B.

Extending this work further, we explored some of the psychological and affective cues that people might use to accurately detect disease using the Lens Model (e.g., Nestler & Back, 2013) in Study 2. Inspired by the findings reviewed above, we investigated whether participants' perceptions of more negative affect, lower conscientiousness, greater risk-taking, lower SES, poorer hygiene, and greater submissiveness might distinguish HIV-infected individuals from their disease-negative counterparts. Adding to the literature showing that stable and visible *physical* cues (e.g., obesity, blemishes, skin coloration) lead perceivers to infer that someone is sick (Buss & Schmitt, 1993), we aimed to test whether *psychological* cues could also facilitate disease detection.

Finally, we predicted that participants' concerns about contamination would moderate their ability to detect disease. Previous research has demonstrated that people's recent experiences with diseases positively correlated with their

attention to, and avoidance of, disfigured individuals (i.e., the overperception of disease) and that people who feel vulnerable to disease overperceive the prevalence of diseases in their environment (Miller & Maner, 2011, 2012). We therefore predicted that individuals with greater disease concern would show greater sensitivity to disease cues. We tested this in Study 3 by experimentally manipulating participants' disease concerns, thereby directly testing how BIS activation affects disease detection.

To summarize, we examined whether perceivers could reliably distinguish between chronically ill and healthy individuals from their faces in Study 1. We then explored the role of subtle affective expressions and psychological cues in inferring disease in Study 2. Finally, we examined how manipulating perceivers' disease concerns can influence their disease detection performance in Study 3. In doing so, we aimed to demonstrate that people could detect not only direct physical, but also indirect behavioral, disease cues from simple and short exposures to others' faces.

## Study 1

Previous research has suggested that people infer the presence of disease in others based on obvious visual cues, such as blemishes, scars, and facial adiposity (e.g., Schaller et al., 2010). Separately, studies have also shown that individuals infer others' traits and states to judge their mental health (e.g., Daros, Ruocco, & Rule, in press; Kleiman & Rule, 2013; Scott, Kramer, Jones, & Ward, 2013). In Study 1, we presented participants with photographs of individuals infected or not infected with a chronic sexually transmitted infectious disease (HIV in Study 1A and herpes in Study 1B) and asked them to categorize these targets as either sick or healthy. Following the predictions of the BIS and the findings of previous work showing interpersonal accuracy in person perception, we hypothesized that people would distinguish infected individuals from their less healthy counterparts more accurately than chance guessing.

### Study 1A

#### Method

**Participants.** Undergraduate students ( $N = 33$ ; 14 female, 19 male;  $M_{\text{age}} = 19.36$  years,  $SD = 3.49$ ) enrolled in an introductory psychology course participated for partial course credit.

**Stimuli.** Hypothesis-blind research assistants downloaded photographs of 124 Caucasian men from gay online dating websites posted in various U.S. cities. Because the websites update automatically when a new user enters and we only downloaded the faces presented on the first few pages, we may assume that the sample represented a random selection of users. Inclusion criteria required that targets directed their faces into the photographer's camera, were free of adornments (e.g., glasses, beards), and described themselves as 18

to 35 years old. Half of the targets self-identified as HIV positive (i.e., sick), whereas the other half self-identified as HIV negative (i.e., healthy). We removed each target's head from the photo's original background, converted it to grayscale, cropped it to the limits of the face, and sized all of the images to a uniform height. Participants therefore saw only the targets' faces and had to rely on this information to make their judgments. Furthermore, a sample of 24 separate participants (15 female, 9 male;  $M_{\text{age}} = 37.67$  years,  $SD = 14.95$ ) pre-rated the faces for attractiveness from 1 (*very unattractive*) to 9 (*very attractive*); inter-rater reliability Cronbach's  $\alpha = .84$ . Comparisons of the mean consensus ratings of the targets in each group revealed no significant differences in attractiveness,  $t(121) = 1.34$ ,  $p = .18$ ,  $r_{\text{effect size}} = .12$ , 95% confidence interval [CI] =  $[-.06, .29]$ .

**Procedure.** The participants viewed the faces in random order on a computer screen and categorized them as either "sick" or "healthy" via key-press. Prior to categorization, we instructed them that "sickness" referred to a prolonged period of chronic illness (e.g., cancer, HIV). On one trial, we changed the title question to "Male or Female?" (altering the response options accordingly) to serve as an attention check question and eliminated the data from eight participants who failed to accurately identify the target's sex (final  $N = 25$ ).<sup>1</sup> We did not provide feedback to the participants about their responses and never disclosed the targets' actual health status. Importantly, aside from the initial description of chronic disease, we did not give the participants any additional information about the particular disease afflicting the targets, rendering it very unlikely that they might have used any stereotypes or stigmas associated with specific diseases to make their judgments. Assuming a 5% false-positive rate and the mean effect size from a recent meta-analysis on the interpersonal perception of subtle group differences ( $r = .29$ ; Tskhay & Rule, 2013), this sample afforded 83% statistical power in a two-tailed one-sample  $t$  test.

**Analytic strategy.** We analyzed the data using signal detection analysis, counting categorizations of HIV-positive targets as "sick" as hits ( $M = .28$ ,  $SD = .13$ ) and categorizations of HIV-negative targets as "sick" as false alarms ( $M = .23$ ,  $SD = .12$ ) to calculate sensitivity ( $A'$ ) and response bias ( $B''$ ) scores for each participant (Macmillan & Creelman, 2005). We then compared the sensitivity scores to chance (.50) and response bias scores to zero (i.e., no bias) using one-sample  $t$  tests. Greater sensitivity indicated higher disease detection accuracy, and positive response bias scores represented a tendency to categorize targets as healthy more often than sick.

**Results and discussion.** Supporting our first hypothesis, participants categorized the targets as "sick" and "healthy" significantly better than chance guessing,  $M_{A'} = .56$ ,  $SD = .10$ ,  $t(24) = 2.74$ ,  $p = .01$ ,  $r_{\text{effect size}} = .49$ , 95% CI =  $[.11, .74]$ ;

thus, they detected unacquainted targets' health status from just photos of their faces. Moreover, they showed a significant tendency to categorize the targets as healthy, rather than sick,  $M_{B'} = .15$ ,  $SD = .15$ ,  $t(24) = 4.93$ ,  $p < .001$ ,  $r_{\text{effect size}} = .71$ , 95% CI = [.44, .86], suggesting that people typically conclude that others are not chronically ill in the absence of overt cues suggesting otherwise.

## Study 1B

### Method

**Participants.** Although we requested 40 workers from Amazon's Mechanical Turk (MTurk) to complete the study for monetary compensation, only 37 individuals (21 female, 16 male;  $M_{\text{age}} = 36.51$  years,  $SD = 13.25$ ) completed it, providing 95% statistical power based on the parameters described in Study 1A.

**Stimuli.** Hypothesis-blind research assistants downloaded photographs of 144 Caucasian men from postings on online dating websites in major U.S. cities. We used the same selection criteria and stimulus preparation procedures as in Study 1A. Half of the men indicated that they tested positive for herpes, whereas the other half of the participants did not indicate that they had any communicable disease (i.e., they did not explicitly indicate that they were herpes negative). An independent group of 31 MTurk workers (15 female, 16 male;  $M_{\text{age}} = 32.61$  years,  $SD = 10.48$ ) judged the faces' attractiveness (Cronbach's  $\alpha = .88$ ) from 1 (*not at all attractive*) to 7 (*very attractive*), rating the targets with herpes ( $M = 3.20$ ,  $SD = 0.44$ ) as significantly less attractive than the healthy controls ( $M = 3.56$ ,  $SD = 0.60$ ),  $t(142) = 4.08$ ,  $p < .001$ ,  $r_{\text{effect size}} = .32$ , 95% CI = [.17, .46].

**Procedure.** Instructions and procedures followed those reported in Study 1A, above.

**Results and discussion.** Similar to Study 1A, we analyzed the data using signal detection analysis in which we counted herpes-positive targets categorized as "sick" as hits ( $M = .50$ ,  $SD = .22$ ) and herpes-negative targets categorized as "sick" as false alarms ( $M = .33$ ,  $SD = .20$ ). On average, participants distinguished herpes-positive men from herpes-negative men significantly better than chance guessing,  $M_{A'} = .65$ ,  $SD = .09$ ,  $t(36) = 10.03$ ,  $p < .001$ ,  $r_{\text{effect size}} = .86$ , 95% CI = [.74, .93], and tended to categorize targets as "healthy" rather than "sick,"  $M_{B'} = .06$ ,  $SD = .17$ ,  $t(36) = 2.14$ ,  $p = .04$ ,  $r_{\text{effect size}} = .34$ , 95% CI = [.02, .60]. Although separate perceivers consensually perceived the faces of herpes-positive men as less attractive than the faces of herpes-negative men, a target-level analysis of accuracy (i.e., aggregating the proportion of correct categorizations across participants for each face) revealed that the participants still categorized the targets more accurately than chance when controlling for attractiveness in a simultaneous multiple regression model,  $b = 0.04$ ,  $SE = 0.01$ ,  $t(141) = 3.63$ ,  $p < .001$ , 95% CI = [.02, .06],  $\beta = .25$ .

Although the results from Study 1B closely paralleled those of Study 1A, they extend them in two important ways. First, participants' ability to identify sickness generalizes beyond just one chronic disease to another illness with few visual indicators. In addition, these findings rule out the possibility that mentioning HIV as an example in our instructions affected participants' categorization accuracy in Study 1A by priming them to evaluate the targets' disease accordingly. That is, although the participants in Study 1B saw the same instructions that explicitly mentioned HIV and cancer, they exhibited comparable and moderate levels of accuracy when categorizing individuals infected with herpes, suggesting that our instructions did not orient the participants toward perceiving HIV. Most important, the results of Studies 1A and 1B collectively demonstrated that participants could reliably infer the presence of disease from limited facial cues. Because the HIV- and herpes-positive targets expressed no obvious physical symptoms distinguishing them from the healthy targets, we therefore sought to understand the potential basis for the subtle differences between them in Study 2.

## Study 2

In Study 1, we found that participants could categorize HIV- and herpes-infected men's faces as sick (vs. healthy) significantly better than chance guessing, supporting our hypothesis that the BIS detects relatively less visible diseases. In Study 2, we explored this further by evaluating the affective and psychological cues that the participants may have used to accurately discern the disease status of unacquainted strangers. Specifically, we predicted that people would perceive ill individuals as displaying more negative affect, poorer hygiene, lower SES, lower conscientiousness, and greater risk-taking and submissiveness than healthy individuals, hypothesizing that perceivers would use some of these cues to accurately infer that they are sick. We tested this by modeling judgments of the HIV-positive and HIV-negative targets from Study 1A in a multiple mediation Lens Model (e.g., Nestler & Back, 2013).

### Method

**Participants.** Although we requested 210 MTurk workers, 244 individuals (126 female, 118 male;  $M_{\text{age}} = 36.33$  years,  $SD = 13.41$ ) actually completed the study across the seven conditions (i.e., judgment types). Of those, 210 received monetary compensation and 34 completed the study without collecting compensation. We planned for sample sizes large enough in each condition to ensure adequate levels of interrater reliability (see Rosenthal & Rosnow, 2008).

**Stimuli.** We used the same stimuli as in Study 1A.

**Procedure.** We collected the data in three waves in which participants viewed the targets individually and in random order.

**Table 1.** Means, Standard Deviations, and Pearson's Product-Moment Correlations Among Perceptions of the Targets in Study 2.

Variable	M (SD)	2	3	4	5	6	7	8
1. Actual disease status	—	.18*	.22*	-.17 <sup>†</sup>	.07	.23**	-.23*	.28**
2. Perceived disease status	0.48 (0.16)	—	.64***	-.64***	.62***	.73***	-.32***	.45***
3. Affect	0.48 (0.37)		—	-.69***	.46***	.54***	-.51***	.55***
4. Conscientiousness	3.07 (0.41)			—	-.72***	-.75***	.26**	-.58***
5. Hygiene	2.62 (0.35)				—	.76***	-.22**	.42***
6. Socioeconomic status	2.89 (0.44)					—	-.23**	.51***
7. Submissiveness	2.96 (0.42)						—	-.69***
8. Risk-taking	4.45 (0.70)							—

<sup>†</sup> $p < .10$ . \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

**Table 2.** Standardized Betas and 95% Confidence Intervals for the Multiple Mediation Lens Model Reported in Study 2.

Cue	Cue Validity		Cue Utility		Accuracy	
	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI
Affect	<b>.21</b>	<b> [.03, .38]</b>	<b>.34</b>	<b> [.15, .52]</b>	<b>.07</b>	<b> [.01, .15]</b>
Conscientiousness	-.17	[-.34, .01]	.04	[-.28, .31]	-.01	[-.07, .05]
Hygiene	.08	[-.10, .26]	.14	[-.10, .35]	.01	[-.02, .05]
Socioeconomic status	<b>.23</b>	<b> [.05, .41]</b>	<b>.49</b>	<b> [.27, .72]</b>	<b>.11</b>	<b> [.02, .22]</b>
Submissiveness	<b>-.23</b>	<b> [-.41, -.05]</b>	-.07	[-.24, .10]	.02	[-.02, .07]
Risk-taking	<b>.27</b>	<b> [.10, .44]</b>	-.09	[-.27, .10]	-.02	[-.08, .03]

Note. Estimates in bold represent relationships that are statistically significant at  $\alpha = .05$ .

We never mentioned either health or disease to the participants. In the first wave, we randomly assigned participants to categorize the targets as “depressed” versus “not depressed” ( $n = 29$ ), or as “smiling” versus “not smiling” ( $n = 34$ ); data for five targets were not recorded due to a programming error. In the second wave, 27 participants rated the targets for “how risky” they seemed from 1 (*not at all risky*) to 9 (*extremely risky*).<sup>2</sup> Finally, in the third wave, we randomly assigned separate samples of participants to rate the targets on conscientiousness (“This person is conscientious”;  $n = 31$ ), hygiene (“This person has poor hygiene”;  $n = 30$ ), SES (“This person is from a lower SES background”;  $n = 30$ ), submissiveness (“This person is submissive”;  $n = 31$ ), and dominance (“This person is dominant”;  $n = 32$ ) from 1 (*strongly disagree*) to 5 (*strongly agree*).

**Analytic strategy.** Because we wanted to examine the psychological and emotional cues that differentiated sick and healthy targets, and to identify the cues that perceivers use to categorize them as such, we analyzed the data using a multiple mediation Lens Model in which each perception (i.e., affect, conscientiousness, hygiene, SES, submissiveness, and riskiness) mediated the link between actual and perceived disease status. Thus, we aggregated all seven measures across participants, generating a mean score for each target (all inter-rater reliability Cronbach's  $\alpha$ s  $\geq .78$ ). The dominance and submissiveness ratings ( $r = -.82$ ), and depression and smiling ( $r = -.88$ ) categorizations, strongly

correlated, and so we averaged them into individual composite variables (Submissiveness and Affect, respectively). We also aggregated the ratings of perceived disease status across the participants in Study 1A to yield the proportion of participants who identified each target as “sick” to use as our main dependent variable, which we square-root transformed to achieve a distribution that resembled normality (Lilliefors test;  $D = .07$ ,  $p = .14$ ).

Notably, this path model completely represents the Lens Model (Nestler & Back, 2013), such that each mediator represents a cue that participants may or may not use (and, complementarily, that targets may or may not display). As such, it allowed us to examine cue validity (*a* paths), cue utility (*b* paths), and the accurate use of cues (*ab*) simultaneously. We also allowed the mediators to correlate freely, thereby accounting for the shared residual variance between them. We fit this model using the structural equation modeling package lavaan (Rosseel, 2012) implemented in R and report standardized regression coefficients and bootstrapped 95% CIs.

## Results and Discussion

**Cue validity.** Cue validity represents the perceptions that actually differentiated the sick and healthy individuals. Here, we found that they differed in perceptions of Affect, SES, Submissiveness, and riskiness (see Table 1 for means, standard deviations, and inter-correlations between the variables; see Table 2 for standardized parameter estimates of the

indirect effects). Specifically, participants perceived the individuals who self-reported as HIV positive as more depressed, as coming from a lower SES background, as less submissive, and as more prone to risk-taking than their healthy counterparts. No other relationships reached traditional levels of statistical significance ( $\alpha = .05$ ).

**Cue utility.** Cue utility represents the perceptions that perceivers use to infer disease. We found that people only used Affect and SES to infer illness. Specifically, perceivers were more likely to categorize the targets as sick (as opposed to healthy) if they appeared sadder and as coming from a lower SES background. No other perceptions meaningfully related to participants' judgments of disease status.

We additionally explored the cues that people associated with health status separately within the sick and healthy target groups via robust multiple regression analysis. We found that people primarily focused on Affect and hygiene when evaluating the HIV-negative targets, such that they more often perceived healthy targets as sick when they seemed more depressed,  $b = 0.22$ ,  $SE = 0.06$ ,  $t(51) = 3.78$ ,  $p < .001$ , 95% CI = [.10, .34],  $\beta = .49$ , or appeared to have poorer hygiene,  $b = 0.16$ ,  $SE = 0.06$ ,  $t(51) = 2.71$ ,  $p = .009$ , 95% CI = [.04, .28],  $\beta = .37$ ; all other  $t$ s  $\leq 1.72$ ,  $p$ s  $\geq .09$ , all other  $|\beta$ s|  $\leq .22$ . When evaluating the HIV-positive targets, however, only perceptions of SES significantly predicted the percentage of participants who had categorized the targets as sick, such that targets perceived as coming from a lower SES background were more often categorized as sick,  $b = 0.27$ ,  $SE = 0.06$ ,  $t(52) = 4.22$ ,  $p < .001$ , 95% CI = [.15, .39],  $\beta = .72$ ; all other  $t$ s  $\leq 1.46$ ,  $p$ s  $\geq .15$ , all other  $|\beta$ s|  $\leq .25$ .

**Accurate use of cues.** Finally, we examined the cues that participants used accurately, derived from the indirect effects from actual to perceived disease status via each cue. This analysis revealed that participants' accuracy was a function of Affect and SES: Participants' accurate disease detection—total effect,  $\beta = .18$ ,  $Z = 1.98$ ,  $p = .05$ , 95% CI = [.00, .35]—became non-significant when accounting for perceptions of negative Affect and SES, direct effect,  $\beta = .01$ ,  $Z = 0.15$ ,  $p = .88$ , 95% CI = [−.11, .12]. These results thus suggest that the HIV-positive and HIV-negative targets differed in Affect and SES, which the participants in Study 1A then used to correctly categorize them as sick and healthy. At the same time, although sick targets appeared riskier than healthy targets, participants did not use this cue to make their judgments. In other words, the participants accurately evaluated other people's health status through the perceptual lens of Affect and SES.

### Study 3

In Study 1, we observed that people could detect disease from men's faces better than chance guessing. In Study 2, we found that they used targets' Affect and perceived SES to make these accurate inferences. Although both studies suggest the

involvement of the psychological disease avoidance system, we have not directly tested whether the BIS indeed plays a role in the detection of such subtle cues (Miller & Maner, 2011, 2012). One premise of the BIS is that individuals who are motivated to avoid disease should be more likely to detect it. Thus, to more definitively establish whether the BIS promotes disease detection, we tested whether people primed with thoughts about an infectious disease (i.e., flu) might more accurately discriminate between sick and healthy others compared with people primed with thoughts about a non-infectious disease (i.e., heart disease) or people not primed at all.

We therefore conducted an experiment in which we encouraged participants to think about either an infectious or non-infectious health threat before completing the categorization task described in Study 1A. However, we predicted that participants' stable dispositions to overperceive disease (i.e., their response bias) would attenuate any difference between the conditions. Specifically, because previous research has suggested that people who feel vulnerable to contamination tend to overperceive disease cues (Miller & Maner, 2011), we predicted that participants who generally assume that others are healthy (i.e., have a high response bias) would become more vigilant to diseases following exposure to a video intended to increase disease concerns (i.e., flu prime), thereby increasing their accuracy in detecting disease. Among participants who already express a high level of contamination concern (i.e., have a low response bias), however, we expected that the flu prime would exert little effect, as these individuals may already be at ceiling in terms of their disease vigilance. Thus, we primed participants with an infectious disease threat (the flu), a non-infectious disease threat (heart disease), or no threat and investigated how this manipulation interacted with their general tendency to accurately construe targets as sick or healthy (i.e., their response bias scores) on measures of their disease detection accuracy from the faces of HIV-positive and HIV-negative men. Moreover, although we found that people could detect disease from faces in both Studies 1A and 1B, because we used relatively small numbers of participants in those studies, we wanted to confirm that result with a larger sample here.

### Method

**Participants.** Although we requested a total of 750 workers from MTurk, 762 individuals (453 female, 307 male, two transgender;  $M_{\text{age}} = 36.18$  years,  $SD = 12.32$ ) actually completed the study. This sample provided more than 99% power to detect differences between the conditions assuming the average effect size in social and personality psychology ( $r = .21$ ; Richard, Bond, & Stokes-Zoota, 2003), and a 5% false-positive rate.

**Stimuli.** To manipulate disease threat, we showed participants one of two videos. Participants in the infectious disease condition viewed a brief (2 min 26 s) educational video about how

the influenza virus enters the body and infects human cells. Although this video primarily described the biochemical process by which influenza infects the body, it had several scenes that we thought would elicit concerns about contamination. Specifically, the video began with a person sneezing and releasing disease agents into the air. Later in the video, the influenza virus multiplies and infects hundreds of neighboring cells (<https://www.youtube.com/watch?v=YSgkoldBNkI>). We edited the original video to make no mention of the immune system's response or any other possible medical solutions to infection. Thus, although the video may have been only mildly arousing, we deemed that it would serve as a good candidate for activating the BIS and raising disease concerns.

Participants in the non-infectious disease condition viewed a brief (1 min 36 s) animated educational video about heart disease (<https://www.youtube.com/watch?v=vUVVjd0vweU>). In the video, the narrator explained the development of chest pain and how it might affect individuals' overall health and increase their risk of heart attack. The video did not contain any information about infectious diseases or the treatment of heart disease.

**Procedure.** We randomly assigned participants to the infectious disease ( $n = 221$ ), non-infectious disease ( $n = 252$ ), or control ( $n = 289$ ) conditions. Participants in the infectious disease condition watched the influenza video and answered three attention check questions (i.e., *Did you watch the video? What was the video about? What virus was described in the video?*); we eliminated data from one participant who reported not watching the video. Participants in the non-infectious disease condition watched the heart disease video and answered two similar attention check questions (i.e., *Did you watch the video? What was the video about?*); all of the participants successfully answered these questions. After watching the video and answering the attention check questions, participants proceeded to the categorization task described in Study 1A. Participants in the control condition saw no video and instead proceeded directly to the categorization task at the start of the study.

Each trial presented a target face at the center of the computer screen with response options "sick" and "healthy" situated immediately below each face. As in Study 1A, we changed the response options on one trial to "Male" and "Female" to serve as an attention check. This attention check trial displayed one of the faces and appeared at a random point during the categorization task. We excluded 191 participants (25.07%) spread equally across all three conditions,  $\chi^2(1) = 0.77, p = .68, \phi = .06$ , from further analysis for incorrectly answering this question, resulting in a final sample of 570 participants (95% power in the conditions with the lowest number of participants) across the flu prime ( $n = 162$ ), heart disease prime ( $n = 186$ ), and no prime ( $n = 222$ ) conditions. Although high, this failure rate falls moderately within the range typically found in studies that use manipulation check questions to monitor data quality (see Oppenheimer,

Meyvis, & Davidenko, 2009).<sup>3</sup> Following the categorization task, participants rated three manipulation check statements (*My friends and family might be carrying diseases at this very moment*, *Interactions with other people put me at a risk of becoming sick*, and *I am under a constant risk of becoming sick*) from 1 (*not at all true*) to 7 (*very true*); internal consistency reliability Cronbach's  $\alpha = .80$ .

## Results and Discussion

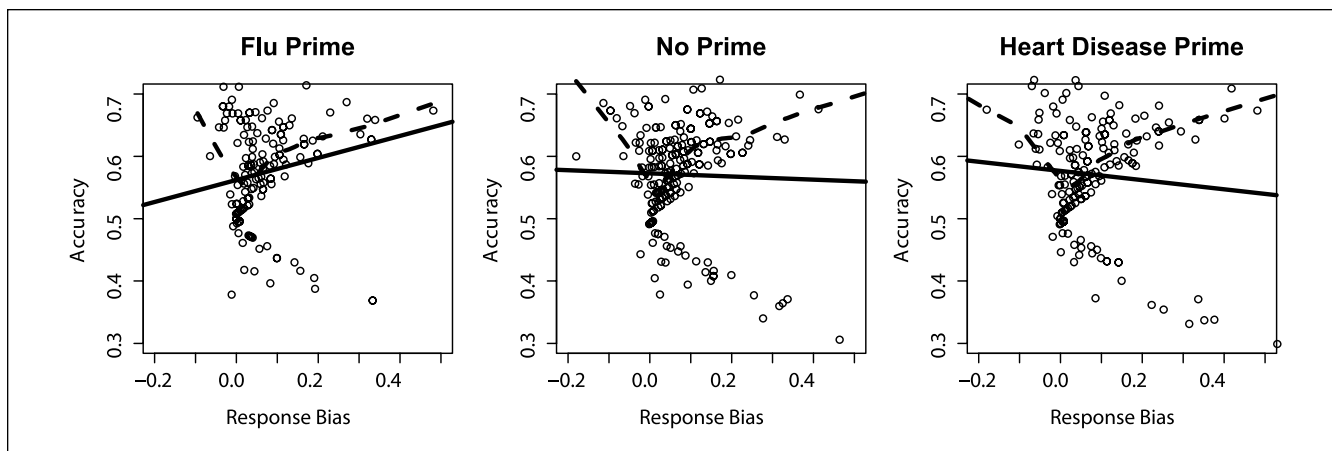
We first tested participants' disease detection accuracy to validate the data. As in Study 1A, we again used signal detection analysis in which we counted sick targets categorized as "sick" as hits ( $M = .33, SD = .19$ ) and healthy targets categorized as "sick" as false alarms ( $M = .26, SD = .15$ ). Overall, participants categorized the targets as sick versus healthy significantly better than chance,  $M_{A'} = .57, SD = .09, t(569) = 20.11, p < .001, r_{\text{effect size}} = .64, 95\% \text{ CI} = [.59, .69]$ , and again demonstrated a significant tendency to categorize targets as healthy rather than sick,  $M_{B''} = .08, SD = .12, t(569) = 15.93, p < .001, r_{\text{effect size}} = .56, 95\% \text{ CI} = [.50, .61]$ . Thus, we replicated the results of Study 1A with a larger sample.

Next, we examined whether our priming manipulation had indeed provoked concerns about becoming sick. Verifying our manipulation, we found that participants' disease vigilance varied as a function of condition,  $F(2, 567) = 5.62, p < .004, \eta^2 = .02$ . Participants in the flu prime condition ( $M = 4.30, SD = 1.61$ ) expressed greater concern with disease than participants in both the heart disease prime,  $M = 3.79, SD = 1.54, t(346) = 3.04, p = .003, r_{\text{effect size}} = .16, 95\% \text{ CI} = [.06, .26]$ , and no prime,  $M = 3.84, SD = 1.56, t(382) = 2.82, p = .005, r_{\text{effect size}} = .14, 95\% \text{ CI} = [.04, .24]$ , conditions, which did not significantly differ,  $t(406) = 0.34, p = .73, r_{\text{effect size}} = .02, 95\% \text{ CI} = [-.08, .12]$ .

We expected to find that the flu prime would affect participants' accuracy differently as a function of their individual bias to categorize the targets as sick versus healthy. Specifically, we anticipated that the prime would not affect participants already vigilant about disease. We therefore predicted that individual differences in participants' response bias would moderate the effect of our disease threat manipulation. We tested this moderation using multiple regression, following the recommendations outlined by Aiken and West (1991). Thus, we grand mean centered the response bias scores, dummy coded the conditions into two predictor variables (flu prime and heart disease prime, with the no prime condition serving as the reference group), and estimated the simple effects at 1  $SD$  above and below the response bias mean.

The analysis revealed no main effects of condition—flu prime,  $b = 0.01, SE = 0.01, t(564) = 0.70, p = .48, 95\% \text{ CI} = [-.01, .02], \beta = .07$ ; heart disease prime,  $b = -0.00, SE = 0.01, t(564) = 0.01, p = .99, 95\% \text{ CI} = [-.02, .02], \beta = -.00$ —or response bias,  $b = -0.03, SE = 0.05, t(564) = 0.55, p = .61, 95\% \text{ CI} = [-.07, .12], \beta = -.04$ . Participants' response bias





**Figure 1.** Relationships between response bias and accuracy among participants primed with the flu (left panel), participants primed with heart disease (right panel), and participants not primed (center panel) in Study 3.  
Note. Solid line = ordinary least squares regression line; dashed line = loess line.

significantly interacted with the flu prime,  $b = 0.20$ ,  $SE = 0.07$ ,  $t(564) = 2.87$ ,  $p = .004$ , 95% CI = [.06, .34],  $\beta = .29$ , but not with the heart disease prime,  $b = -0.05$ ,  $SE = 0.07$ ,  $t(564) = 0.69$ ,  $p = .49$ , 95% CI = [-.19, .09],  $\beta = -.07$ .

The simple effects analysis revealed that categorization accuracy significantly increased among participants who assume that other people are generally healthy when they were exposed to a flu prime compared with when they were not primed at all or when primed with heart disease,  $b = 0.03$ ,  $SE = 0.01$ ,  $t(564) = 2.52$ ,  $p = .011$ , 95% CI = [.01, .05],  $\beta = .36$ . Critically, participants who systematically labeled others as sick showed no such improvement when primed,  $b = -0.02$ ,  $SE = 0.01$ ,  $t(564) = -1.52$ ,  $p = .13$ , 95% CI = [-.04, .01],  $\beta = -.22$ . Thus, only people who assumed most targets to be healthy were significantly affected by the flu prime (see Figure 1).

Imparting concerns about disease therefore affected participants' accuracy in categorizing targets as sick and healthy. Experimentally increasing disease concern improved accuracy for individuals with a bias to perceive others as healthy but did not affect the accuracy of individuals already biased to perceive others as sick. Importantly, priming participants to think about a non-infectious disease (i.e., heart disease) did not change their accuracy. Consistent with the predictions of the BIS and ecological theories about the functionality of perception (Schaller, 2008; Zebrowitz & Collins, 1997), these effects therefore suggest that the motivation to avoid disease may make people better attuned to its presence.

## General Discussion

In the current work, we addressed a foundational axiom of the BIS that individuals can accurately identify others' disease status using minimal cues (Schaller & Duncan, 2007). Specifically, the present findings showed that (a) diseases

lacking clear physical markers were perceptible at levels that exceeded chance guessing, (b) facial Affect and perceived SES cued perceivers to the presence of diseases, and (c) BIS activation facilitated disease detection among individuals primed to think about disease. Collectively, these findings provided a novel demonstration of the BIS's influence on perception and cognition while also supplying additional evidence for individuals' sensitivity to ecologically meaningful social cues.

## Theoretical Implications

Previous research has suggested that the BIS facilitates disease detection (Miller & Maner, 2011, 2012; Schaller, 2008; Schaller & Duncan, 2007). The present work therefore validates the theoretical proposition of the functionality of the BIS by demonstrating that it responds not only to diseases marked by visible physical symptoms but also to diseases with subtler, psychological cues. Furthermore, experimentally activating the perceivers' BIS allowed them to identify infected people more accurately, suggesting an increase in their attunement to threat (McArthur & Baron, 1983; Zebrowitz & Collins, 1997).

Furthermore, we found that both relatively fleeting (Affect) and more stable (SES) indirect cues to disease supported its detection. People therefore respond not only to obvious physical disease cues (e.g., scars, blemishes, and sneezing; Schaller et al., 2010) but also to subtle psychological disease cues, such as perceptions of negative emotions and fewer financial resources. Namely, the data suggest that people overgeneralize perceptions associated with disease to infer whether others are sick or healthy. Indeed, previous research demonstrated that chronically ill individuals often present with negative affect (e.g., depression; Kelly et al., 1993) and that individuals from lower socioeconomic backgrounds more often become sick (Link & Phelan, 1995).

These cues may therefore compose people's implicit beliefs about individuals who are ill. In addition, the BIS may motivate people to attune to perceptually obvious cues to disease as well as its psychobehavioral manifestations.

We also found that participants tended to categorize others as healthy. This result may appear inconsistent with previous research in which people typically overperceived the presence of disease (Miller & Maner, 2012). Miller and Maner (2012) reasoned that disease avoidance should primarily manifest among people concerned about contamination, suggesting that overgeneralizing disease perception could substantially limit the evolutionary benefits of social interaction. However, they used a categorization paradigm with targets that explicitly carried highly obvious *overt* disease cues (e.g., obesity) and focused primarily on how those cues affected perceivers' memory for the targets. Responses to relatively covert disease cues (such as the indirect psychological markers examined here) might proceed differently. Thus, the previous and current work may represent different levels of processing that complement each other to achieve the same end (i.e., individual health and survival). For instance, a bias toward labeling targets as healthy may encourage affiliation in the absence of overt disease cues. People may therefore tend to overgeneralize disease heuristics when confronting explicit disease cues (leading them to encode those people better) but might assume that others are generally healthy when salient disease cues are absent. After all, if people otherwise assumed that others are diseased by default, they likely would avoid social interactions to protect themselves against contamination. In concert with the prior work, the current findings present a more complete picture of how people may perceive and respond to diseases that manifest in different ways.

Accordingly, future research may benefit from examining the psychobehavioral manifestations of disease alongside established physical manifestations. Although perceptions of Affect and SES supported the identification of disease in the current work, other psychological factors might also assist perceivers in making these categorizations and perceivers may use multiple physical and psychological cues simultaneously to assess potential health risks (e.g., Lefevre & Perrett, 2015) and to ensure reproductive success (e.g., Rule et al., 2008). Indeed, the psychological representation of disease could trigger a response in the perceivers' biological immune system (see Schaller et al., 2010). Thus, understanding how and to what extent disease cues (both subtle and obvious) influence implicit cognition and explicit behaviors could provide interesting fodder for a better understanding of mind-body connections.

Interestingly, participants seemed to diverge in which of these cues they used to evaluate the healthy versus sick targets. Whereas they used Affect and hygiene to evaluate the HIV-negative targets as sick versus healthy, they used SES to decide the HIV-positive targets' health status. People therefore appear to use different strategies when assessing the

health of individuals from each group, despite no knowledge about who belonged to which. This suggests that the participants might have implicitly evaluated the targets' health status and thereafter used a different set of cues for each group—an interesting possibility worthy of future research.

Finally, examining people's ability to detect disease from the perspective of the BIS and interpersonal accuracy allowed us to demonstrate that people can reliably detect others' disease status and that relatively ambiguous psychological cues may support these judgments. Although we did not employ measures traditionally used in the BIS literature (e.g., recency of illness or the Perceived Vulnerability to Disease Scale; Duncan, Schaller, & Park, 2009), integrating our findings with those established previously using different tools may provide novel insights about the theory and process underlying accurate disease detection. Future researchers might therefore benefit from considering multiple perspectives in their examination of disease detection.

### *Potential Practical Implications*

These findings might also potentially interest health care professionals. Although we only studied people infected with HIV and herpes, perceptions of psychological and behavioral cues to physical distress and SES might also manifest alongside other inconspicuous maladies (e.g., cancer). Furthermore, we measured perceptions of *sickness*, rather than of HIV or herpes directly. Thus, participants did not know which disease or diseases afflicted the targets, suggesting that similar perceptual processes might generalize to other diseases as well. Supporting this, we found comparable levels of accuracy for perceptions of HIV and herpes. Information about the use of subtle disease cues in perception might therefore help to improve doctor-patient interactions (Hall, Horgan, Stein, & Roter, 2002), physical diagnosis (Fletcher & Fletcher, 1992; Re & Rule, 2016), patient counseling (Eichler, Ray, & del Rio, 2002), and public health policy more broadly (Schaller, Murray, & Bangerter, 2015).

### *Limitations*

Although we found that participants detected illness at above-chance levels via perceptions of Affect and SES, other differences in facial appearance between sick and healthy individuals could exist as well. For example, the immunological processes that defend against illness also expend carotenoids (Krinsky, 1998), an antioxidant phytochemical that provides the skin with a healthy looking yellow-orange coloration and that perceivers rely upon when judging others' health (Stephen, Smith, Stirrat, & Perrett, 2009; Whitehead, Re, Xiao, Ozakinci, & Perrett, 2012). Thus, patients with HIV and herpes could show slight skin color differences compared with healthy individuals. Although we removed the color information from the images in our studies, future research may seek to examine this as a potentially

meaningful difference. Furthermore, although we never told the participants which specific diseases the targets had, future work could incorporate other diseases (e.g., non-infectious chronic diseases or acute infectious diseases) to confirm the present findings.

Furthermore, and related to the previous point, these data are limited in scope due to their correlational nature. Indeed, a number of additional alternative explanations of the effects are also possible. This is especially apparent in the cue utility component of the Lens Model where people's impressions of targets on one dimension determine perceptions of their health. In the present work, both greater negative Affect and lower SES predicted perceptions of sickness. Some might therefore suspect a halo effect whereby negatively valenced impressions lead to perceptions of other undesirable attributes, such as sickness. Given that we did not observe similar correlations between sickness and other negative qualities (e.g., poor hygiene), we do not suspect such a negative halo to be responsible for the findings we observed. An experimental design that systematically manipulates specific variables would provide a stronger test of how perceptions of sickness are formed.

In addition, because we focused on two sexually transmitted diseases that have emerged relatively recently (i.e., HIV and herpes), these diseases would not likely have influenced the evolution of the BIS in humans. Nevertheless, we found that experimentally activating individuals' concerns about disease promoted disease detection accuracy for some participants. Thus, people may dynamically adopt disease detection mechanisms via the BIS whenever they perceive a disease threat. Critically, because none of the participants knew the specific disease relevant to their judgments in these studies, their successful detection of these diseases through a general sick versus healthy judgment supports the likelihood that the BIS flexibly accommodates various (longstanding and novel) diseases. Accordingly, because HIV and herpes constitute relatively new diseases, they present an especially conservative test of the BIS's sensitivity. Future researchers may therefore wish to examine whether people respond more to diseases that might have coevolved with the BIS.

Another limitation concerns our use of stimuli from online dating websites, which prevented us from ensuring that the targets had self-reported their disease status accurately. For instance, although concealing one's HIV-positive status from a sexual partner is illegal in some places (*R. v. Cuerrier; 1998*), people may not wish to advertise their illness in dating profiles. Moreover, many individuals do not know that they are infected with some of the diseases that they carry (Centers for Disease Control and Prevention, 2011). Similarly, people may put careful effort into choosing photos for their personal advertisements that enhance their attractiveness, likely leading sick people to choose photos in which they look healthier (Rhodes, 2006). Each of these influences would have underestimated the size of the effects by confusing membership across the two groups. Thus, the true effect

sizes may be larger than what we have observed here; future researchers may therefore wish to explore disease perception further by photographing infected people under standardized, controlled conditions.

Finally, we only used *perceived* cues to disease in this research and do not know the targets' actual levels of conscientiousness, SES, hygiene, Submissiveness, risk-taking, or Affect. Although this approach may be useful for understanding the implicit theories that people use to infer disease, it limits our knowledge of veridical differences between the targets. Moreover, participants only judged the targets as sick or healthy, thus curtailing one's ability to directly diagnose HIV or herpes from a person's appearance specifically.

## Conclusion

Overall, the present studies have important implications for the perception of disease. Our findings resonate with theories from evolutionary and ecological psychology at the nexus with interpersonal accuracy and add to them by demonstrating that people can accurately extract disease relevant information from minimal appearance cues. Thus, people appear to use physical, psychological, and behavioral expressions of disease symptoms to protect themselves from parasites and infections.

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## Supplemental Material

The online supplemental material is available at <http://pspb.sagepub.com/supplemental>.

## Notes

1. Because we did not include attention check questions in all of our studies, we only report these data when available.
2. We provided only one example of risky behavior (sexual promiscuity).
3. Participants who did not pass the attention check achieved marginally lower accuracy,  $b = 0.01$ ,  $SE < 0.01$ ,  $t(760) = 1.91$ ,  $p = .06$ , 95% CI = [.00, .01],  $\beta = .07$ , and significantly greater response bias,  $b = -0.02$ ,  $SE = 0.01$ ,  $t(760) = 2.91$ ,  $p = .004$ , 95% CI = [-.03, -.01],  $\beta = -.11$ , than those who answered the attention

check questions correctly, suggesting that they were less engaged with the task and also validating the attention check's efficacy.

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