

Testing the Domain-Specificity of the
Disease-Avoidance and Self-Protection Systems

by

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ABSTRACT

An emerging body of literature suggests that humans likely have multiple threat avoidance systems that enable us to detect and avoid threats in our environment, such as disease threats and physical safety threats. These systems are presumed to be domain-specific, each handling one class of potential threats, and previous research generally supports this assumption. Previous research has not, however, directly tested the domain-specificity of disease avoidance and self-protection by showing that activating one threat management system does not lead to responses consistent only with a different threat management system. Here, the domain-specificity of the disease avoidance and self-protection systems is directly tested using the lexical decision task, a measure of stereotype accessibility, and the implicit association test. Results, although inconclusive, more strongly support a series of domain-specific threat management systems than a single, domain-general system

To Mandi, Mom, and Dad

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An emerging body of literature suggests that humans likely have multiple threat avoidance systems that enable us to detect and avoid threats in our environment (Schaller, Park, & Mueller, 2003; Park, Schaller, & Crandall, 2007; Cosmides & Tooby, 2005). These systems are presumed to be domain-specific, each dealing solely with one class of potential threats (e.g. Neuberg, Kenrick, & Schaller, 2011). Although the evidence collected thus far is consistent with domain-specific models of threat avoidance, the independence of these systems has not been directly tested. Here, I first briefly review the broader literature on features of threat management systems. This is followed by a more focused discussion of two proposed threat systems (the disease avoidance and self-protection systems). Finally, I present a series of studies designed to test the independence of the disease avoidance and self-protection systems using methods of prejudice and stereotyping research.

Features Common to all Threat Management Systems

Though the specifics may differ from system to system, all threat management systems should share some key features. First, all threat management systems should be biased toward over-detecting threat. Time is of the essence when dealing with threats in the environment, so threat systems should choose speed of processing over accuracy. Some mistakes are more costly than others, however, and researchers have argued that whenever the costs associated with classes of errors are consistently asymmetric, evolved systems should be biased in the least costly direction (Haselton & Buss, 2000; Haselton & Nettle, 2006). Threat management systems should thus be risk-averse. The costs associated with

mistakenly inferring threat (i.e. missed opportunities) are much less severe than the costs of missing an actual threat (i.e. potential death).

Second, all threat management systems should be sensitive to contexts indicating enhanced danger. Although over-perceiving threats is generally less costly than the alternative, it does still carry costs. One way to reduce these misfires is to prime the system only in the presence of cues suggesting danger is imminent. Lowering response thresholds in potentially dangerous situations and raising them in less dangerous situations allow organisms to reduce both false alarms and misses. Cues of potential threat may be situational (e.g. being alone, darkness, strange odors) or individuals may have chronically lowered thresholds.

Finally, all threat management systems should coordinate an adaptive series of responses. Threat detection is only the first step; an organism must also respond to danger. Threat management systems should therefore organize perceptual, cognitive, affective, and behavioral responses to reduce the negative outcomes associated with the detected threat.

Previous Research on Threat Management

Having reviewed the general features of threat management systems, I now turn to two frequently studied systems: the disease avoidance system and the self-protection system.

The disease avoidance system. Humans have been threatened by pathogens throughout our evolutionary history—a selection pressure that has led to our sophisticated immune system. Despite its functional importance, the immune system is a costly last line of defense against contagion, only effective

after coming into contact with a disease-causing pathogen. Once activated, the immune system consumes considerable metabolic resources, and some features of the immune response, such as fever and swelling, are further debilitating. Given these high potential costs, individuals should benefit from activating the immune system as infrequently as possible (Schaller & Duncan, 2007).

Schaller and colleagues have proposed the existence of a *behavioral immune system* shaped by natural selection to protect the body from contagion before actual contamination occurs (e.g. Schaller, 2006; Schaller & Duncan, 2007). This system consists of mechanisms that promote the detection of potential pathogens through olfactory (e.g. foul or unusual odors) and visual cues (e.g. lesions, physical abnormalities, and spoiled food). Once a potential disease threat is detected, the behavioral immune system activates a set of behaviors and cognitions that reduce the likelihood of contact with those pathogens. Recent research suggests that psychological cues may even pre-activate the immune response. For example, Schaller et al. (2010) found that simply viewing photos of people with various diseases and skin lesions led to increased production of interleukin-6, a proinflammatory cytokine. By enabling us to avoid contamination in the first place, the behavioral immune system reduces the need for a full-blown physiological immune response.

As expected, the disease avoidance system is risk-averse, tending to over-perceive health threats. Research has shown that individuals respond to physical abnormalities, such as obesity, birthmarks, and physical disabilities, as if they were cues to contagious diseases, even if they are aware that no objective health

threat exists (Park, Schaller, & Crandall, 2007; Schaller & Duncan, 2007; Park, Faulkner, & Schaller, 2003).

The disease avoidance system also appears to be context-sensitive. Watching a short slideshow about the threat of disease increases the likelihood of disease-avoidant cognitions (e.g. Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010; Faulkner, Schaller, Park, & Duncan, 2004; Park et al., 2007). Effects differ as a function of individual differences as well. Individuals who chronically feel vulnerable to disease are more avoidant (Mortensen et al., 2010). They also have fewer friends with physical disabilities and more strongly associate physical disabilities with disease (Park et al., 2003).

Once activated, the disease avoidance system sets into motion a series of adaptive responses. Attentional resources are focused on individuals who appear to pose a risk of infection (Ackerman, Becker, Mortensen, Sasaki, Neuberg, & Kenrick, 2009). Cognitive associations are altered such that potentially diseased individuals are judged more harshly (Navarrete, Fessler, & Eng, 2007; Park et al., 2007). The disease avoidance system even modifies self-perceptions, leading individuals to see themselves as less extraverted, less agreeable, and less open to new experiences (Mortensen et al., 2010). Behaviorally, approach movements are inhibited (Mortensen et al., 2010).

The self-protection system. In addition to disease threats, humans have also faced physical violence throughout evolutionary history. These threats have shaped a self-protection system that is attuned to cues that others may seek to intentionally harm us, such as an angry expression, or environmental cues that we

may be particularly at risk, such as darkness or being alone. Once detected, the self-protection system coordinates affective, cognitive, and behavioral responses that minimize the chance of harm.

Research on the self-protection system has shown that it exhibits the features that are characteristic of all threat management systems. The self-protection system is risk-averse. Men (especially outgroup men) are more likely to pose a threat to our physical safety (e.g. Daly & Wilson, 1994), and research has found that men are more likely to be mistakenly perceived as angry (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007; Maner et al., 2005; Becker, Neel, & Anderson, 2010). Additionally, fear associated with outgroup men is extinguished more slowly than fear associated with women or ingroup men (Olsson, Ebert, Banaji, & Phelps, 2005; Navarrete, Olsson, Ho, Mendes, Thomsen, & Sidanius, 2009).

The self-protection system also appears to be context sensitive. For example, humans have relatively poor night vision, leaving us especially vulnerable in the dark. We might expect this increased vulnerability to result in lower response thresholds associated with self-protection. Consistent with this notion, startle responses are exaggerated in the dark (Grillon, Pellowski, Merikangas, & Davis, 1997). Ambient darkness also increases the accessibility of threat-relevant stereotypes. In one set of studies, Schaller and colleagues (2003) had participants view a slideshow of Black men in either a dimly lit or completely dark room. They were then asked to rate the extent that specific traits described the cultural stereotypes of Blacks. Results indicated that threat-relevant

stereotypes were more strongly activated under conditions of darkness, especially among individuals who chronically believe the world is a dangerous place. A second study replicated this finding using a safety/danger Implicit Association Test (IAT; Greenwald, Nosek, & Banaji, 1998): under dark conditions, people who believe the world is dangerous more strongly associated Black targets with threat than safety.

Like the disease avoidance system, the self-protection system appears to deploy a well-coordinated set of responses once activated. Increasing visual attention to a threatening person could be seen as a challenge, so the self-protection system does not redirect visual attention toward physical threats. Rather, it appears to redirect *encoding* resources, increasing memory for the potential threats without incurring the potential cost of increased attention (Ackerman et al., 2006; Becker et al., 2010). The self-protection system increases the accessibility of threat-relevant stereotypes, but not other equally negative stereotypes, and associations between outgroup men and danger are tightened (Schaller et al., 2003). The self-protection system elicits fear, which promotes escape behaviors (Cottrell & Neuberg, 2005).

Are They Domain-Specific?

As the research reviewed above has shown, the activation of the disease avoidance system or the self-protection system reliably leads to a predictable pattern of results, and these patterns differ from one type of threat to another. Although the findings are largely consistent with notions of multiple independent threat systems, researchers have yet to directly test the domain-specificity of

disease avoidance and self-protection. Demonstrating that activating self-protection increases the accessibility of physical threat relevant stereotypes in a physically threatening outgroup is only the first step. In order to truly test our assumptions of independence, we must also show that activating self-protection *does not* increase the accessibility of disease-relevant stereotypes. The converse is also true: activating disease avoidance should not increase the accessibility of physical threat relevant stereotypes if the systems are truly independent. In contrast, if activating one threat system leads to behaviors and cognitions closely associated with a different threat system, one can infer some degree of overlap between the two systems.

The Current Study

The current study was designed to test the independence of the disease avoidance system and the self-protection system. The general approach will be to activate one of the threat systems using visual stimuli, then measure participants' responses on a lexical decision task, an explicit stereotype accessibility task, and an implicit association test. These three dependent variables (and their expected results) are described below.

Lexical decision task. The lexical decision task measures concept activation by asking participants to rapidly decide whether a sequence of letters is a word or nonword. Previous work has found that participants are able to more quickly identify a word if a related concept has been primed. For example, Meyer & Schvanevelt (1971) had participants indicate whether pairs of letter sequences formed words or nonword. In some of the trials, the words were unrelated (e.g.

“bread” and “doctor”), while in other trials, the words were semantically related (e.g. “bread” and “butter”). Results indicated that participants were able to make the word/nonword decision more quickly when the words were semantically related. Other researchers have found that viewing images of elderly individuals decreases response times for words that are stereotypic of the elderly (e.g., “serious”) compared to nonstereotypic words (e.g., “jealous”) (Kawakami, Young, & Dovidio, 2002).

In the current study, if threat management systems are, in fact, domain-specific, then words should be identified most quickly if the relevant threat management system has been activated. Activating unrelated threat management systems should have no effect on the speed of identification. So, for example, disease-relevant words should be identified most quickly when the disease avoidance system has been activated. Activating the self-protection system, in contrast, should not change response times from control. An analogous pattern was expected for danger-relevant words: fastest identification among participants primed with self-protection, but no change from control among participants primed with disease avoidance.

A domain-general system should lead to a very different pattern of results. Here, threat-relevant words, regardless of content, should be identified more quickly (compared to control) after activating any type of threat. In the current study, participants who have had either the disease-avoidance or self-protection systems activated should identify both disease- and danger-relevant words more

quickly than participants in the control condition. Figure 1 visually depicts the predicted pattern of results for both domain-specific and domain-general systems.

Stereotype accessibility. As described above, research by Schaller and colleagues found that participants in a darkened room rated danger-relevant traits (but not simply negative traits) as more typical of the popular cultural stereotype of Black than did participants in a well-lit room. This suggests that activating threat leads to increased accessibility of threat-relevant stereotypes. The current study seeks to expand on Schaller's work by asking participants to rate the typicality of not only negative and danger-relevant traits, but also disease-relevant traits. If the threat management systems are domain-specific, then disease-relevant traits should be rated as more typical by participants primed with disease avoidance compared to participants primed with self-protection and control participants. Danger-relevant traits, in contrast, should be rated most typical by participants primed with self-protection.

A domain-general system should result in a different pattern of findings. Here, all threat-relevant traits (regardless of content) should be rated as more typical whenever any type of threat has been activated. That is, participants should rate both disease- and danger-relevant traits as more typical in both the disease avoidance and self-protection conditions compared to control.

Implicit Association Test. The IAT uses reaction times to measure the relative strength of association between two groups (e.g. Blacks vs. Whites) and a specific trait (e.g., physical threat). Previous work has shown that activating the disease avoidance system strengthens the associations between obese people and

disease (Park et al., 2007), while activating the self-protection system strengthens the associations between Blacks and physical danger (Schaller et al., 2003). The current study builds on this research by measuring associations between Mexican immigrants and both disease and physical danger. Additionally, the current study measures male and female targets separately.

If the threat management system is domain-specific, associations between Mexican immigrants and disease should strengthen only after activating disease avoidance. Because men and women are equally able to carry and transmit disease, no gender difference is expected for associations with disease. In contrast, associations between Mexican immigrants and physical danger should strengthen only after activating self-protections. Here, a gender difference was expected. Because men are more likely than women to pose a threat to our physical safety (e.g. Daly & Wilson, 1994), the expected strengthened association between Mexican immigrants and danger should only be found for male targets.

A domain-general system should lead to strengthened associations with both disease and danger for male and female Mexican immigrants, regardless of what type of threat has been activated.

Method

Participants

Three hundred and nineteen (201 females) undergraduates enrolled in an introductory psychology course participated in exchange for partial fulfillment of a course requirement. Because the experiment focused on perceptions of Mexican

immigrants, participants who identified themselves as Hispanic were excluded from the analysis ($n = 58$). An additional 12 participants were excluded based on experimenter reports that participants were rushing through the study, sending text messages during the study, suffering from a hangover, or otherwise not giving the study their full attention. The final sample consisted of 249 participants (160 females) with a mean age of 18.86 years ($SD = 2.90$, range = 18 – 52). Table 1 shows the gender breakdown within condition.

Materials

Threat manipulations. In order to activate one of the threat management systems, participants viewed one of three slideshows previously used by Schaller et al. (2010). These slideshows contained 10 images viewed for 5 seconds each. The self-protection slideshow featured images of individuals pointing guns at the viewer. The disease avoidance slideshow featured images of individuals suffering from skin lesions or showing other signs of illness. The control slideshow featured images of various types of furniture, such as couches, tables, and beds.

Manipulation boosters. Before viewing the slideshow, participants were informed that they would be asked questions about the similarity of the slideshow stimuli throughout the study. Prior to each dependent measure, participants were shown ten pairs of photos taken from the threat manipulation slideshows and asked to rate how similar they were to each other using a 9-point scale where 1 = “*Very Different*” and 9 = “*Identical*.” In reality, these similarity judgments were intended to boost and maintain the threat motivation by requiring participants to view the images again.

Dependent measures. Participants completed three dependent measures: a lexical decision task, a stereotype accessibility task, and an implicit association test. The order of these tasks was randomized across participants.

Lexical decision task. The lexical decision task requires participants to quickly categorize a sequence of letters as either a word or nonword. The task consisted of 30 words (ten exemplars in each of three categories: disease words, danger words, and neutral words) and 30 pronounceable nonwords presented individually (See Appendix A for the full list of stimuli). Participants were instructed to press the “E” key if the stimulus was a word and the “I” key if the stimulus was not a word. Each word or nonword remained visible on the computer monitor until participants made their decisions, and no feedback was given regarding the accuracy of participants’ categorizations.

Stereotype accessibility. Following the procedure used by Schaller et al. (2003), participants were asked to rate the extent to which a series of 16 traits were part of the common cultural stereotypes of two groups: Canadian immigrants and Mexican immigrants. Written instructions emphasized that the task was intended to measure the content of cultural stereotypes, not the participants’ personal beliefs about the groups. Using a 9-point scale (1 = *Not at all*, 9 = *Very much*), participants rated four exemplars of each of four types of traits: generally positive (*hard-working, friendly, family-oriented, modest*), generally negative (*lazy, uneducated, arrogant, disrespectful*), disease relevant (*dirty, smelly, sickly, malnourished*), and danger relevant (*aggressive, hostile, combative, dangerous*).

Participants completed all 16 ratings for Canadian immigrants separately from Mexican immigrants. The order of the ratings was randomized within group, and the order of the groups was randomized between participants.

Implicit Association Test (IAT). The IAT uses reaction times to measure the relative strength of association between two groups (e.g. Mexican vs. Canadian immigrants) and a specific trait (e.g., physical threat). Participants completed four separate IATs designed to measure the strength of their associations of male and female immigrants with physical threat and disease threat. Each IAT consisted of two categorization tasks. The Mexican vs. Canadian categorization task required participants to classify photos of young adults (described as students at universities in Mexico or Canada) as either Mexican or Canadian. Participants completed separate IATs for male and female targets. The threat categorization task required participants to classify words into one of two concepts. In the physical threat IATs, participants categorized words as connoting either danger (*aggressive, assault, hit, punch, murder*) or safety (*tranquil, safe, peace, secure, trust*). In the disease threat IATs, participants categorized words as connoting either disease (*contagious, illness, infection, vomit, epidemic*) or health (*healthy, clean, sanitary, hygienic, well*). In the key sets of trials, participants are asked to simultaneously classify pictures and words.

For example, to assess strength of associations between Mexican immigrants and physical threat, response times when categorizing stimuli as “Canadian or Safety” or “Mexican or Danger” are compared to response times when categorizing stimuli as “Canadian or Danger” or “Mexican or Safety.”

Faster response times in the blocks pairing Mexican and Danger than in the blocks pairing Mexican and Safety are interpreted as reflecting a closer cognitive association between Mexicans and physical threat. See Table 2 for an overview of the disease threat IAT design.

Procedure

Participants completed the study in groups of three or fewer. With the exception of the initial introduction, all instructions and stimuli were presented via computer. After being greeted by the experimenter, participants were seated individually at a computer and given a consent form to read and sign. The experimenter explained that the participants would be completing a variety of tasks during the session, the first of which explored how perceptions of similarity change over time. Participants then viewed one of the threat manipulation slideshows. Following the slideshow, participants completed the three dependent measures, each of which was preceded by a manipulation booster. Participants then completed a demographics questionnaire, were debriefed, thanked for their participation, and dismissed.

Results

Lexical Decision Task

Data cleaning. The mean response time for each word type was calculated for each participant, and responses faster than 100 ms or more than 2.5 standard deviations above the participant's mean response time for that word type were dropped. This resulted in the elimination of 3.7% of total trials. Additionally, eight participants with overall accuracy below 66% were removed

from the analysis, leaving a final sample size of 241 (153 women). The mean response time for remaining trials was approximately 949 ms ($SD = 408$ ms). Mean overall accuracy was 96% ($SD = 0.5\%$).

Response times. Only correct responses were included in the analysis of response times. Participants' response times were entered into a 3 (Word Type: neutral, disease, danger) x 3 (Threat Manipulation: control, disease avoidance, self-protection) x 2 (Participant Gender) mixed ANOVA where word type was a within-subjects factor.

Results indicated that there was no main effect of threat manipulation, nor were there any significant interactions involving threat manipulations, all $ps > .18$, indicating that participants response times did not vary as a function of the type of threat activated. There was, however, a significant interaction between word type and participant gender, $F(2, 470) = 5.83, p = .003$, such that men responded more quickly to danger words ($M = 830, SE = 42$) than both neutral words ($M = 1037, SE = 55$) and disease words ($M = 1005, SE = 51$). There were no significant differences in women's response times as a function of word type (all $ps > .14$).

Although the lack of a Word Type x Threat Manipulation interaction strongly suggests that the observed results are not consistent with a domain-specific threat system, a series of contrasts were used to verify this assertion. For each word type, three contrasts were used to test all pairwise comparisons of threat manipulation (i.e. control vs. disease avoidance, control vs. self-protection, and disease avoidance vs. self-protection).

Using disease avoidance as an example, a domain-specific system would be supported by the data if 1) the responses times for disease words by participants in the disease avoidance condition were significantly faster than both the control and self-protection conditions, and 2) the response times in the self-protection condition were not significantly different from control.

A domain-general threat system, in contrast, would be supported by the data if the response times for disease words by participants in either threat condition were faster than the control condition, but were not significantly different from each other. In other words, activating any type of threat leads to faster responses to disease words. Figure 1 visually depicts the patterns that would support a domain-specific system (Panel A) and a domain-general system (Panel B).

As suggested by the non-significant interaction, response times for disease words was unaffected by threat manipulation, all F s < 0.10 (See Figure 2). One might be tempted to interpret the lack of a significant difference between the disease avoidance and self-protection conditions as supporting a domain-general view of threat management, but the non-significant differences between control and either of the threat conditions suggests that the threat manipulation simply had no effect on responses to disease words.

The effect of threat condition on response times for danger words was tested next. As above, three contrasts were used to test all pairwise comparisons of threat manipulation. The logic of the tests remained the same: a domain-specific system would be supported by the data if 1) the response times for danger

words by participants in the self-protection condition were significantly faster than both the control and disease avoidance conditions, and 2) the response times in the disease avoidance condition were not significantly different from control. A domain-general system, in contrast, would be supported by the data if the response times for danger words by participants in either threat condition were faster than the control condition, but were not significantly different from each other.

Like disease words, response times for danger words were unaffected by the threat manipulation, all $F_s < 0.10$. Like disease words, the threat manipulation simply had no effect on responses to danger words.

Accuracy. For each participant, accuracy scores (proportion correct) were calculated for each word type. Accuracy scores were entered into a 3 (Word Type: neutral, disease, danger) x 3 (Threat Manipulation: control, disease avoidance, self-protection) x 2 (Participant Gender) mixed ANOVA where word type was a within-subjects factor.

Results indicated a significant three-way interaction of word type, threat manipulation, and participant gender, $F(4, 470) = 2.91, p = .02$ (See Figure 3). No other main effects or interactions were significant (all $p_s > .30$). The three contrasts described previously were used to test whether the observed pattern of results were more consistent with a domain-specific or domain-general threat management system. The significant three-way interaction indicates that accuracy was influenced by participant gender, so men and women were analyzed separately.

Looking first at men's accuracy for disease words, the contrasts indicate that, consistent with a domain-specific system, men in the disease avoidance condition were marginally more accurate than men in the self-protection condition, $F(1, 238) = 3.24, p = .07$, and the control condition, $F(1, 238) = 2.55, p = .11$. Additionally, men in the self-protection condition were not more accurate than men in the control condition, $F < 0.10$, which is also consistent with a domain-specific system.

Interestingly, men's accuracy for danger words followed a similar pattern: men in the disease avoidance condition were marginally more accurate than men in the self-protection condition, $F(1, 238) = 3.12, p = .08$, and the control condition, $F(1, 238) = 2.11, p = .16$. Again, the difference between participants in the self-protection and control conditions was non-significant, $F < 0.20$. This suggests that activating disease avoidance increases recognition accuracy for words associated with any type of threat.

In contrast to men, women's ability to accurately recognize disease words was not affected by the threat manipulation, all F s < 0.20 . Women's accuracy for danger words, however, were consistent with a domain-specific system: women in the self-protection condition were marginally more accurate than women in the disease avoidance condition, $F(1, 238) = 2.65, p = .11$, and significantly more accurate than women in the control condition, $F(1, 238) = 6.09, p = .01$. The difference between women in the control and disease-threat conditions was not significant, $F < 0.60$.

Stereotype Accessibility

Mean scores for each trait category were calculated separately for Mexican and Canadian immigrants. Overall, participants rated all traits as more typical of Mexican immigrants than Canadian immigrants (all $ps < .001$). Because participants did not hold strong stereotypes of Canadian immigrants, their ratings of Canadians provide a baseline measure of their willingness to say a trait is part of the cultural stereotype. Accordingly, three difference scores were calculated by subtracting the mean ratings for Canadians on negative, disease, and danger traits from the mean ratings for Mexicans on the traits. A table containing the raw scores for both immigrant groups can be found in Appendix B.

Participants' difference scores were entered into a 3 (Trait: negative, disease, danger) x 3 (Threat Manipulation: control, disease avoidance, self-protection) x 2 (Participant Gender) mixed ANOVA where trait was a within-subjects factor. Results indicated that the three-way interaction of trait, threat manipulation, and participant gender was not significant, $F < 0.60$. There was, however, a significant two-way interaction between trait and participant sex, $F(2, 486) = 6.50, p = .002$, such that men rated traits indicating physical danger ($M = 3.21, SE = .23$) as more typical than did women ($M = 2.36, SE = .17$). The gender differences for negative and disease traits were not significant, $F_s < 1.0$.

Relevant to the test of domain-specificity, the two-way interaction of trait and threat manipulation was also significant, $F(1, 486) = 3.12, p = .015$ (See Figure 4). The three contrasts described previously were used to test whether the

observed pattern of results were more consistent with a domain-specific or domain-general threat management system.

If the system is domain-specific, participants in the disease avoidance condition should rate disease-relevant traits as more typical of Mexican immigrants than participants in either the control or self-protection conditions. Additionally, the ratings of participants in the self-protection condition should not differ from the ratings of control participants. In contrast, if the system is domain-general, the ratings of disease-relevant traits should not differ between participants in either threat condition, but both threat conditions should be different from control.

Results indicated mixed support for the domain-specific system. Participants in the disease avoidance condition rated disease-relevant traits as more typical than did control participants, $F(1, 246) = 4.23, p = .04$, and the difference between the self-protection and control conditions was not significant, $F(1, 246) = 1.20, p = .28$. Both of these findings are consistent with a domain-specific system. The difference between the disease-relevant trait ratings of participants in the disease avoidance and self-protection condition, however, was not significant, $F < 1.0$, which is more consistent with a domain-general threat system.

The same logic was used to test the effects of threat manipulation on participants' ratings of danger-relevant traits. Here, all three contrasts were not significant (all $ps > .29$), indicating that ratings of traits related to physical danger were unaffected by the threat manipulation.

Implicit Association Test

Data loss. Due to a programming error, the data from three of the four IATs were lost. (Each participant's final IAT was recorded.) However, because the presentation order of the IATs was randomized, data for each type of IAT were collected between participants. However, continuing to include participant gender in the analysis would have resulted in an unacceptably small number of participants in some cells, so results were collapsed across participant gender.

To compensate for the data loss, an additional 160 participants (80 females) participated in a second study consisting only of the threat manipulation slideshow (and similarity ratings), the four IATs, and a demographic questionnaire. As with the initial study, participants who identified themselves as Hispanic ($n = 28$) and troublesome participants ($n=11$) were excluded from the analysis. The results of both studies (hereafter referred to as "Study 1" and "Study 2") are presented below. Table 3 shows the gender breakdown within condition for Study 2.

Scoring procedure. The IATs were scored according to the updated algorithm recommended by Greenwald, Nosek, and Banaji (2003). As part of this scoring process, twelve participants from Study 1 and five from Study 2 who responded to more than 10% of trials in less than 300 ms were excluded from the analysis, leaving 237 participants (154 females) in Study 1 and 124 participants (56 females) in Study 2. The IAT was scored so that positive values indicated that Mexicans were more strongly associated with threat than were Canadians.

Analysis.

Study 1. The calculated IAT scores were entered into a 3 (Threat Manipulation: control, disease avoidance, self-protection) x 2 (IAT Gender: male vs. female) x 2 (IAT Threat: danger vs. disease) ANOVA. None of the interactions or main effects reached traditional levels of significance, but the three-way interaction of threat manipulation, IAT gender, and IAT threat was suggestive, $F(1, 225) = 1.78, p = .17$, and warranted further probing. As would be expected from a domain-specific system, the simple IAT Gender x IAT Threat interaction was significant for participants in the self-protection condition, $F(1, 225) = 5.49, p = .02$, but not for participants in the control or disease avoidance conditions, both $F_s < 0.40$ (See Figure 5).

Next, the three pairwise contrasts described previously were used to test whether the observed pattern of results were more consistent with a domain-specific or domain-general threat management system. Because the effects vary as a function of target gender, male and female targets were analyzed separately.

In a domain-specific system, participants in the self-protection condition should more closely associate male Mexican immigrants with physical danger than participants in the disease avoidance or control conditions, which should not be significantly different from one another. Contrasts confirm this pattern: in the self-protection condition males were more closely associated with danger than in disease avoidance, $F(1, 225) = 5.86, p = .02$, and control, $F(1, 225) = 3.61, p = .06$. The difference between control and disease avoidance was not significant, $F < 0.40$.

The pattern of results for the disease IAT for males were in the expected direction for a domain-specific system, but failed to reach traditional levels of significance. There was a non-significant trend for males to be more closely associated with disease by participants in the disease avoidance condition compared to participants in the self-protection condition, $F(1, 225) = 1.71, p = .19$, and associations with disease did not differ between the control and self-protection conditions, $F(1, 225) = 0.38, p = .54$. Despite being in the expected direction, participants in the disease avoidance condition did not more strongly associate male Mexican immigrants with disease than control participants, $F(1, 225) = 0.60, p = .44$.

As would be expected in a domain-specific system, participants' association between female Mexican immigrants and physical danger did not vary as a function of threat manipulation, all $F_s < 0.10$. Contrary to both a domain-specific and domain-general system, participants' association between female Mexican immigrants and disease threat also failed to vary as a function of threat manipulation, all $F_s < 0.40$.

Study 2. The calculated IAT scores were entered into a 3 (Threat Manipulation: control, disease avoidance, self-protection) x 2 (IAT Gender: male vs. female) x 2 (IAT Threat: physical vs. disease) x 2 (Participant Gender: male vs. female) Mixed ANOVA with IAT Threat and IAT Gender as within variables.

Results indicated a significant two-way interaction of IAT Threat and Participant Gender, $F(1, 118) = 7.13, p < .01$. Overall, female participants tended to more closely associate Mexican immigrants with disease ($M = 0.29, SE = .04$)

than did male participants ($M = 0.20$, $SE = .04$), $F(1, 122) = 3.34$, $p = .07$. There was no gender difference in participants' associations of Mexican immigrants with physical danger, $F(1, 122) = 0.83$, $p = .37$. No other interactions or main effects were significant.

The lack of a significant two- or three-way interaction involving type of IAT threat and threat manipulation indicates that participants' IAT scores did not vary as a function of these two variables. As such, none of the pairwise contrasts used to test for domain-specificity were significant, all $ps > .29$. (See Figure 6)

The lack of significant IAT effects in Study 2 may be a result of participant fatigue. If this is true, the first IAT each participant completed should provide a cleaner measure, as the threat manipulation is temporally closer and fatigue should not yet be an issue. Therefore, the IAT scores from each of participant's first IAT was entered into a 3 (Threat Manipulation: control, disease avoidance, self-protection) x 2 (IAT Gender: male vs. female) x 2 (IAT Threat: physical vs. disease) ANOVA. As with the previously reported IAT, results were collapsed across participant gender to avoid unacceptably low sample sizes per cell.

As expected, analyzing only at the first IAT reveals a different pattern of results. Here, there is a significant Threat Manipulation x IAT Threat interaction, $F(2, 112) = 4.39$, $p = .02$, indicating that participants' IAT scores varied as a function of these two variables. Pairwise contrasts were again used to test with which type of the observed pattern of results is more consistent with a domain-specific or domain-general system. Because Study 1 suggested that target gender

might also have an effect on IAT scores, the simple IAT Gender x IAT Threat interactions were analyzed within each threat condition. This interaction was marginally significant for participants in the self-protection condition, $F(1, 112) = 3.22, p = .08$, but not for participants in the control or disease avoidance conditions, both $F_s < 0.50$. As such, the male and female IATs were analyzed separately. (See Figure 7)

Recall that in a domain-specific system, participants in the self-protection condition should more strongly associate male Mexican immigrants with physical danger than participants in the disease avoidance or control conditions, which should not be significantly different from one another. Contrasts confirmed this pattern: in the self-protection condition, males were more strongly associated with physical danger than in disease avoidance, $F(1, 112) = 4.59, p = .03$, and control, $F(1, 112) = 3.25, p = .07$. The difference between control and disease avoidance was not significant, $F < 0.30$.

Again, the pattern of results for the disease IAT for males were in the expected direction for a domain-specific system, but not statistically significant. Males were more closely associated with disease by participants in the disease avoidance condition compared to participants in the self-protection condition, $F(1, 112) = 5.23, p = .02$. There was a non-significant trend for associations with disease to be lower in the self-protection condition than control, $F(1, 112) = 2.51, p = .12$, which, although not necessarily predicted in a domain-specific system, is not inconsistent with one, as activating the disease avoidance system could lead to suppression of other threat management systems. Finally, despite being in the

expected direction, participants in the disease avoidance condition did not more strongly associate male Mexican immigrants with disease than did control participants, $F(1, 112) = 0.69, p = .41$.

As was found in the first IAT, the threat manipulation did not affect participants' associations of female Mexican immigrants with physical danger or disease, all $ps > 0.24$.

Discussion

Previous research has suggested that humans possess a series of domain-specific threat management systems that function to reduce the negative outcomes of commonly encountered threats. One frequently studied threat management system, the disease avoidance system, reduces the potential negative effects of pathogens. Another, the self-protection system, reduces the potential negative effects of those who may seek to physically harm us.

Researchers have repeatedly demonstrated that activating the disease avoidance or self-protection systems reliably leads to a predictable (and functional) pattern of results (e.g., Ackerman et al., 2009; Becker et al., 2010; Mortensen et al., 2010; Navarrete et al., 2009; Park et al., 2007; Schaller et al., 2010; Schaller et al., 2003). Although consistent with multiple, domain-specific threat management systems, the previous findings cannot rule out a single, domain-general threat management system that responds to multiple different threats. The current study sought to expand on this previous work by directly testing the specificity of these two threat management systems.

Although far from conclusive, the pattern of results across three dependent variables (lexical decision task, stereotype accessibility, and the Implicit Association Test) and two participant samples tended to support multiple domain-specific threat management systems more frequently than they supported a single, domain-general threat management system.

The most promising evidence comes from the implicit association test. In both reported IATs, the pattern of results for male targets was consistent with a domain-specific view of threat management. Activating the self-protection system strengthened participants' associations between male Mexican immigrants and physical danger, but these same associations were unaffected by activating the disease avoidance system. Also consistent with a domain-specific view of threat management, female targets, who typically pose less physical danger than males, were less strongly associated with physical danger, and this association was unaffected by the threat manipulation. These findings are consistent with previous research demonstrating that a self-protective motivation leads outgroup males to be viewed as more physically threatening but does not affect perceptions of females (e.g., Maner et al., 2005).

An analogous (albeit non-significant) pattern of results was found for associations between male Mexican immigrants and disease threats: activating the disease avoidance system led participants to more closely associate these men with disease than did participants in the self-protection or control conditions. Unexpectedly, associations between female Mexican immigrants and disease were unaffected by the threat manipulation. Unlike physical threat, both males

and females should be equally likely to pose a disease threat, so females were expected to be more strongly associated with disease by participants in the disease avoidance condition.

Although the results of the lexical decision and stereotype accessibility tasks fail to shed much light on the domain-specific vs. domain-general debate, they are consistent with the male-warrior hypothesis (Van Vugt, De Cremer, & Janssen, 2007). Proponents of the male-warrior hypothesis argue that an evolutionary history of violent intergroup conflict has led males to become more intergroup oriented than females. Extending this logic, males should view outgroup members as especially threatening, and they should be more chronically attuned to potential dangers in the environment. Consistent with these expectations, males (compared to females) assigned higher typicality ratings to danger-relevant traits in the stereotype accessibility task and responded more quickly to danger words in the lexical decision task.

Not all of the evidence was consistent with a domain-specific threat management system. Male participants primed with disease avoidance more accurately identified all threat words than did participants in the control or self-protection conditions. This may represent a spurious effect, as a truly domain-general system should also have led participants in the self-protection condition to show increased accuracy to all threat words. An intriguing alternative is that the increased accuracy under a disease avoidance motivation reflects another form of domain-specificity. Whereas threats to physical safety may prioritize rapid, but perhaps less accurate, responses, threats to our health may best be avoided via

more controlled, accurate responses. Here, responses may be domain-specific at the level of the threat rather than at the level of target.

Limitations

Although the current study found little evidence suggesting domain-general systems, many comparisons failed to reach statistical significance and were thus inconsistent with both domain-general and domain-specific threat management systems. Why the inconsistent findings? One possibility is that the threat manipulations were not strong enough to produce the desired effects. Simply viewing a slideshow of images in a controlled laboratory setting is very different from actually encountering a sick or angry person and may not have been engaging enough to properly activate the desired system.

In some sense, the lexical decision task should have served as a manipulation check. Just as participants in the study by Kawakami et al. (2002) were able to more quickly identify “serious” as a word than “jealous” after viewing images of the elderly, participants in the current study who were concerned with avoiding disease should have been able to more quickly identify “mucus” as a word than “copper.” This was not the case, however. Results indicated that response times in the lexical decision task were unaffected by the threat manipulation. It is tempting to interpret this as indicative of a failed manipulation. However, the significant effects of the threat manipulation on the other dependent measures argue against this interpretation.

Another, perhaps more plausible, explanation is that participants simply took too long to respond to the stimuli. In order to measure the strength of concept

activation, participants need to rapidly make the word/nonword decisions. The relatively slower average response times compared to other lexical decision studies and high overall accuracy rates (96%) suggest that participants should have been encouraged to respond more quickly. In either case, future studies should consider using stronger manipulations, such as video clips, vignettes, or manipulations involving confederates.

The present study represents a conservative test of the domain-specificity of threat management systems. Although vivid images were used to activate the threat systems, words can also have powerful effects on our behavior. In one study, for example, merely using words related to rudeness (e.g., *impolitely* or *infringe*) increased the likelihood that participants would later interrupt the experimenter, while using words related to the elderly (e.g., *retired* or *bingo*) led participants to walk more slowly down a hallway. (Bargh, Chen, & Burrows, 1996). It seems reasonable to conclude, then, that simply viewing words related to disease and physical danger during the course of the three dependent measures may have been sufficient to activate both the disease avoidance and self-protection systems to some degree. If so, then the effects of the threat manipulation would be greatly reduced.

Future Directions

One way to potentially reduce the priming effects of the word stimuli would be to use a completely between-subjects design. Here, after activating one of the threat management systems, participants would be shown stimuli related to only one type of threat. So, for example, a participant might complete a lexical

decision task comparing disease words to neutral words, a stereotype accessibility task comparing disease traits to negative traits, and a disease IAT. Although the cost in terms of participant hours would be substantially greater than the mixed design used in the current study, this new design should provide a cleaner measure by reducing priming effects. This design also has the benefit of being shorter, so participant fatigue would also be less of an issue.

More generally, researchers should investigate the domain-specificity of other proposed threat management systems. Neuberg et al. (2011) argue that domain-specific threat management systems may exist to help mitigate the negative effects of threats against any fundamental social motivation (e.g. gaining status, attracting a mate, keeping a mate, etc.). One such system is the cheater detection system (e.g., Cosmides & Tooby, 2005). The cheater detection system evolved to manage reciprocity threat—that is, the danger that someone will receive a benefit (such as food, money, sexual partner) without having met the required social obligations.

A study exploring cheater detection could use methods quite similar to those in the current study, as Mexicans are also viewed as posing a strong reciprocity threat (Cottrell & Neuberg, 2005). Future research could activate the cheater detection system and measure the activation of reciprocity relevant concepts, the accessibility of reciprocity-relevant traits (e.g., *lazy, uneducated, poor*), and measure the strength of the association between Mexicans and cheating. Studying the cheater detection system could be especially interesting, as the associated emotion, anger, encourages approach rather than avoidance, which is encouraged

by disgust and fear, the emotions underlying disease avoidance and self-protection.

In addition to the methods used in the current study, the approach/avoidance methods used by Mortensen et al. (2010) could lead to interesting results. One should expect that activating the cheater detection system would cause participants to make approach movements more rapidly than avoidance movements. One might also expect changes in self-perceived personality traits. Whereas Mortensen and colleagues found that disease avoidance led individuals to rate themselves as less extroverted, cheater detection should lead individuals to rate themselves as more extroverted, as that would facilitate approaching potential cheaters. Agreeableness, in contrast, should remain low in both cheater detection and disease avoidance.

Conclusion

It appears, then, that the question of the domain-specificity of the disease-avoidance and self-protection system remains unanswered. Although inconclusive, this study represents an important first step in exploring a critical, but overlooked assumption of human psychology. Future researchers should use the methods and ideas discussed here to build a strong program of research exploring human threat management.

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Table 1

Number of Participants per Threat Condition

Threat Condition	Participant Gender	
	Female	Male
Control	57	32
Disease Avoidance	50	32
Self-Protection	53	25

Table 2

Sequence of Blocks for the Disease/Health IAT

Block	No. of Trials	Stimuli	Key Label	
			Left	Right
1	20	Words	Disease	Health
2	20	Photos	Canadian	Mexican
3	20	Both	Canadian or Disease	Mexican or Health
4	40	Both	Canadian or Disease	Mexican or Health
5	20	Photos	Mexican	Canadian
6	20	Both	Mexican or Disease	Canadian or Health
7	40	Both	Mexican or Disease	Canadian or Health

Table 3

Number of Participants per Threat Condition in the Second IAT

Threat Condition	Participant Gender	
	Female	Male
Control	16	24
Disease Avoidance	21	19
Self-Protection	19	25

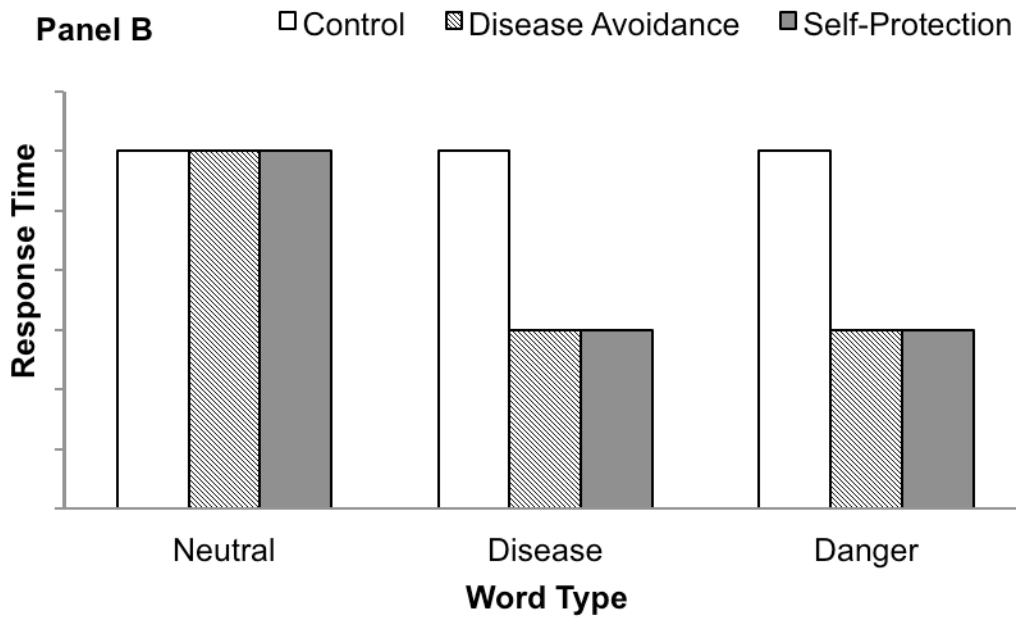
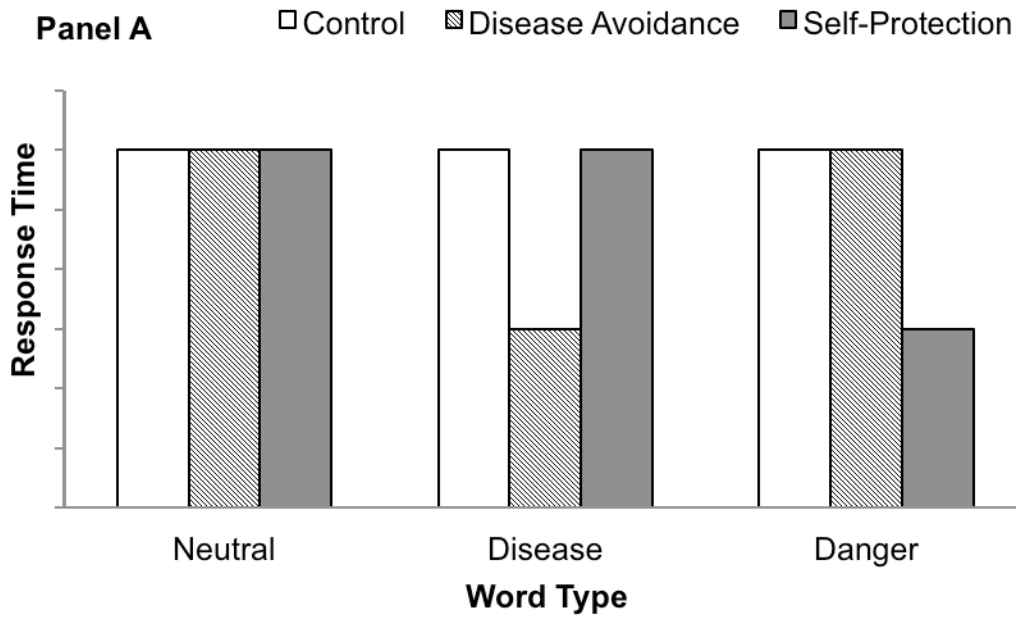


Figure 1. Expected pattern of response times in the lexical decision task broken down by word type and threat manipulation for a domain-specific (Panel A) and domain-general (Panel B) threat management system. Shorter bars indicate faster responses.

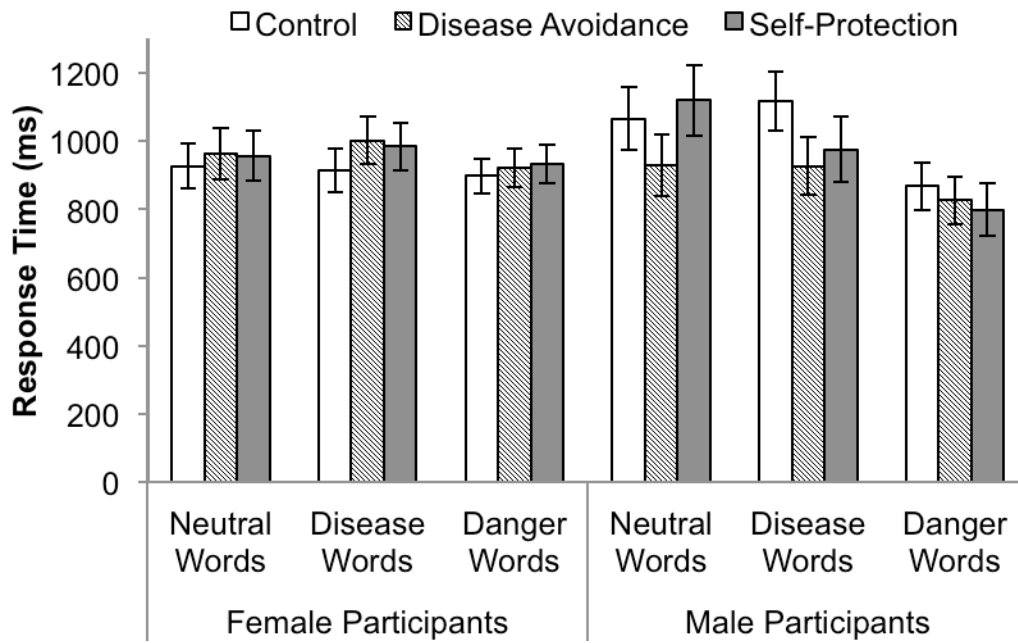


Figure 2. Mean response times (in ms) for correct trials in the lexical decision task as a function of threat manipulation, participant gender, and word type. Shorter bars indicate faster responses. Error bars represent standard errors.

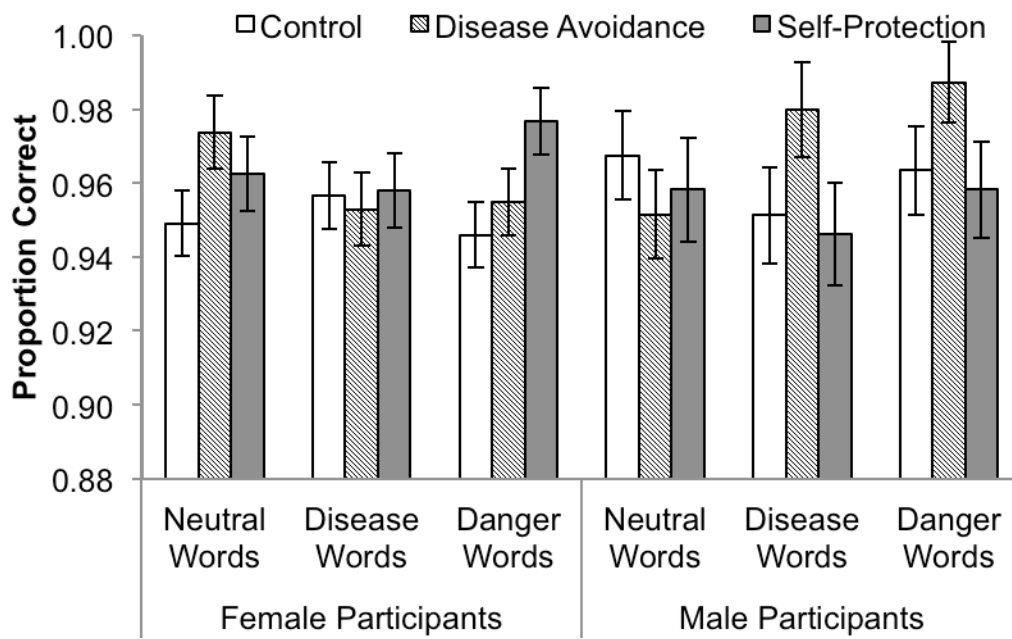


Figure 3. Proportion of correct responses in the lexical decision task as a function of threat manipulation, word type, and participant gender. Error bars represent standard errors.

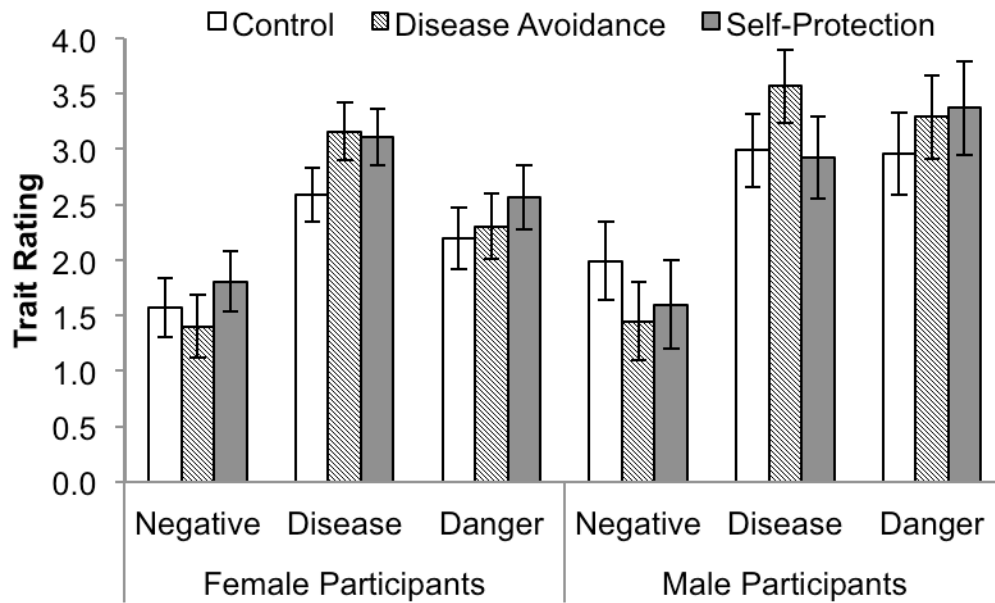


Figure 4. Mean stereotype rating as a function of threat manipulation, participant gender, and trait. Bars represent the difference between Mexican immigrants and Canadian immigrants. Error bars represent standard errors.

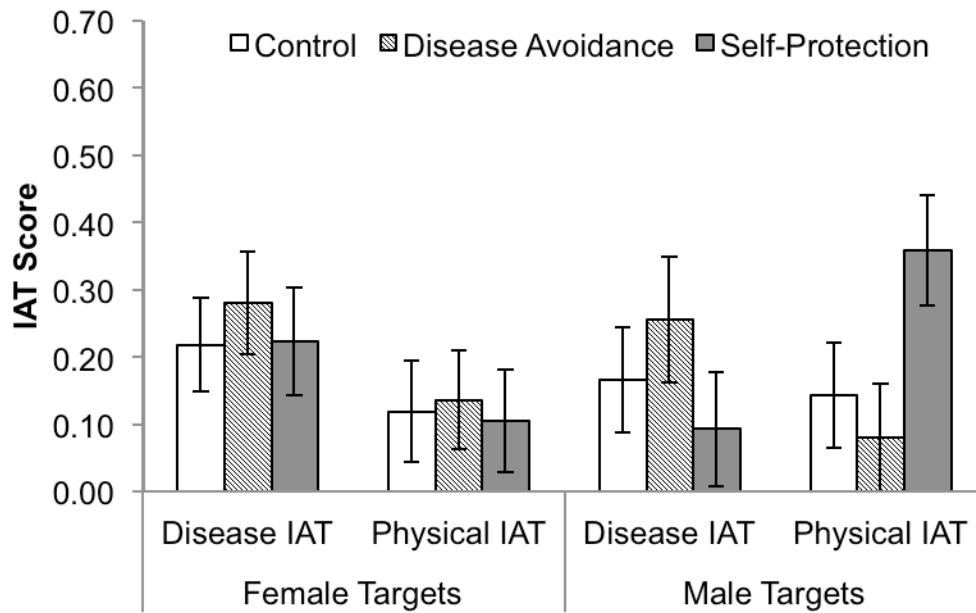


Figure 5. Mean IAT scores as a function of threat manipulation, IAT threat, and target gender in the Study 1 IAT. Higher numbers indicate closer associations between Mexican immigrants and the threat indicated. Error bars represent standard errors.

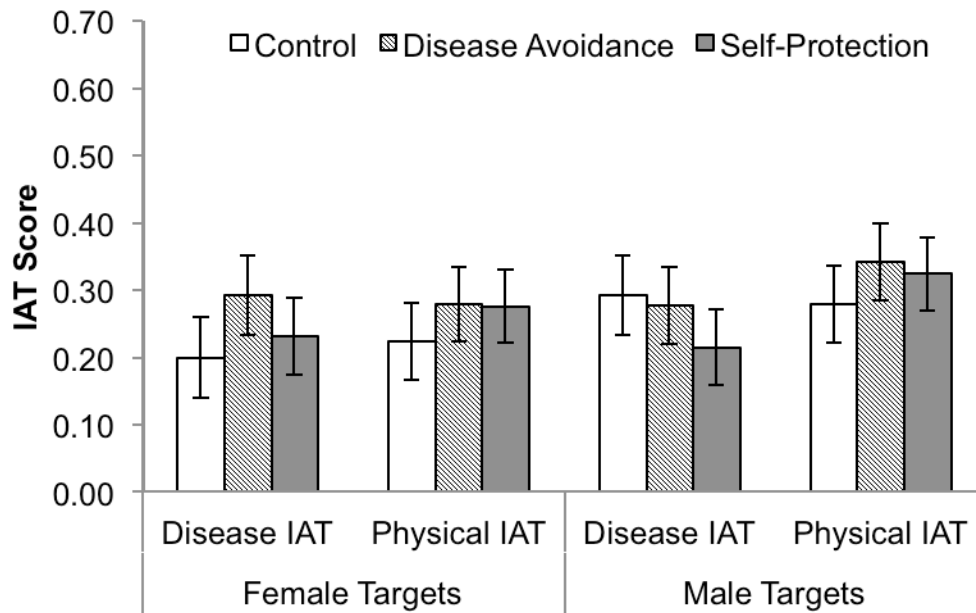


Figure 6. Mean IAT scores as a function of threat manipulation, target gender, and IAT threat in the Study 2 IAT. Higher numbers indicate closer associations between Mexican immigrants and the threat indicated. Error bars represent standard errors.

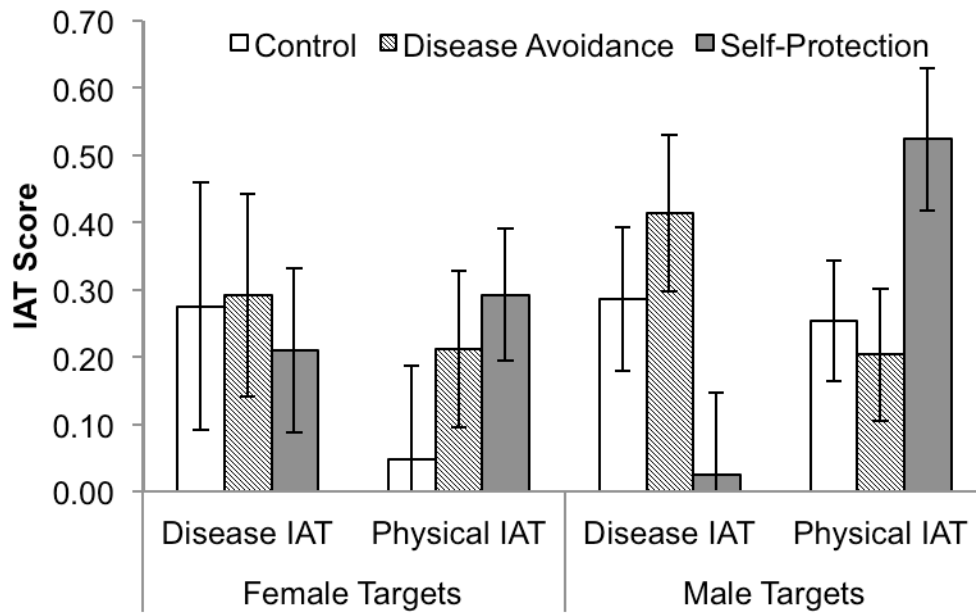


Figure 7. Mean IAT scores for the as a function of threat manipulation, IAT threat, and target gender in the Study 2 IAT (first IAT only). Higher numbers indicate closer associations between Mexican immigrants and the threat indicated. Error bars represent standard errors.

APPENDIX A

STIMULI USED IN THE LEXICAL DECISION TASK

Table A1

Stimuli Used in the Lexical Decision Task

Words			Nonwords		
Danger	Disease	Neutral	A	B	C
Punch	Germs	Spoon	Bloo	Bord	Launter
Gun	Flu	Pants	Pade	Coar	Poondle
Stab	Sneeze	Thumb	Rume	Wate	Pawdle
Knife	Cough	Chess	Wite	Werd	Coarded
Kill	Sick	Beaded	Hoap	Peech	Stroaling
Violent	Mucus	Thinking	Frum	Grume	Balew
Murder	Fever	Jade	Feal	Chier	Stramber
Assault	Rotting	Copper	Reech	Brume	Narrons
Weapon	Moldy	Sailboat	Liest	Nale	Potant
Harass	Poison	Rated	Cace	Soke	Stason

APPENDIX B

RAW STEREOTYPE ACCESSIBILITY SCORES

Table B1

Raw Mean Scores From the Stereotype Accessibility Measure (Standard Error in Parentheses)

Trait	Canadian		Mexican	
	Female	Male	Female	Male
	Control			
Negative	3.59 (0.18)	3.24 (0.24)	5.16 (0.20)	5.16 (0.27)
Disease	2.72 (0.17)	2.48 (0.23)	5.31 (0.20)	5.48 (0.27)
Danger	3.24 (0.19)	2.48 (0.26)	5.44 (0.21)	5.44 (0.29)
	Disease Avoidance			
Negative	3.91 (0.19)	3.72 (0.24)	5.31 (0.21)	5.16 (0.27)
Disease	2.52 (0.19)	2.18 (0.23)	5.67 (0.22)	5.75 (0.27)
Danger	3.29 (0.20)	2.46 (0.26)	5.59 (0.23)	5.75 (0.29)
	Self-Protection			
Negative	3.37 (0.19)	3.44 (0.27)	5.17 (0.21)	5.04 (0.3)
Disease	2.47 (0.18)	2.32 (0.26)	5.58 (0.21)	5.24 (0.31)
Danger	3.08 (0.20)	2.2 (0.29)	5.64 (0.22)	5.57 (0.32)

APPENDIX C
HUMAN SUBJECTS APPROVAL DOCUMENTS

To: David Becker
Santa Catalina

From: Mark Roosa, Chair *MR*
Soc Beh IRB

Date: 09/16/2010

Committee Action: **Amendment to Approved Protocol**

Approval Date: 09/16/2010

Review Type: Expedited F12

IRB Protocol #: 0701001467

Study Title: Toward a Functionalist Psychophysics of Social Perception

Expiration Date: 01/18/2011

The amendment to the above-referenced protocol has been APPROVED following Expedited Review by the Institutional Review Board. This approval does not replace any departmental or other approvals that may be required. It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Soc Beh IRB does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

Arizona State University
Office of Research Integrity and Assurance
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Tempe, AZ 85287-1103
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Fax: (480) 965-7772



For Office Use
Date Received



ASU IRB Approved
Sign: *sm*
Date: 8/27/10

Modification Form Institutional Review Board (IRB)

INVESTIGATOR INFORMATION	
PROTOCOL TITLE: Toward a Functionalist Psychophysics of Social Perception	HS # 0701001467 <i>A003</i>
PRINCIPAL INVESTIGATOR: David Becker	DEPARTMENT/CENTER: Department of Applied Psychology
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FUNDING STATUS: If project is funded or funding is being sought, provide list of all sponsors and grant numbers:	
TYPE OF MODIFICATION (CHECK ALL THAT APPLY)	
Please attach any revised documents (forms, scripts, etc). Attach a brief summary of the proposed changes as well as a justification.	
<input type="checkbox"/>	New Procedures Attach a description of the new procedures and a revised consent form.
<input type="checkbox"/>	Study Title Change What is the new title?
<input type="checkbox"/>	Change in Study Personnel <input type="checkbox"/> Add (include the name, role, and contact information. Include copies of training certificates: http://researchintegrity.asu.edu/training/humans <input type="checkbox"/> Delete
<input type="checkbox"/>	Change of Site <input type="checkbox"/> Add (include the name and location. If this changes the enrollment, that should be noted below.) <input type="checkbox"/> Modify <input type="checkbox"/> Delete
<input type="checkbox"/>	Change in Enrollment Attach a narrative justifying the change. If this will affect the consent, send a revised consent form as well.
<input type="checkbox"/>	Consent Change Attach a copy and describe the change(s).
<input type="checkbox"/>	Advertisement Attach copies of the advertisement or announcement.
<input checked="" type="checkbox"/>	Instruments (surveys, questionnaires, interviews, etc) Attach copies of the proposed instruments and describe any changes from the approved protocol. If you are adding or deleting any instruments or items to an instrument, describe what the changes are and submit the revised materials.
<input type="checkbox"/>	Other Describe the changes. If this affects the consent process, submit a revised consent form.
SIGNATURE	
PRINCIPAL INVESTIGATOR: Vaughn Becker	Name (first, middle, last): D. Vaughn Becker <i>[Signature]</i>
	Signature: <i>D. VAUGHN BECKER</i> Date: 8/27/10

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