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Perceived vulnerability to disease: Development and validation of a 15-item self-report instrument

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ABSTRACT

Many phenomena in the realm of social cognition and behavior are influenced by the extent to which individuals perceive themselves to be vulnerable to infectious diseases. Existing individual-difference measures that might assess this construct are limited in their applicability. This article reports the development and psychometric evaluation of a 15-item perceived vulnerability to disease questionnaire, designed to assess individual differences in chronic concerns about the transmission of infectious diseases. Data from 1539 respondents revealed that the 15 items loaded on two internally consistent subscales. One subscale assesses beliefs about one's own susceptibility to infectious diseases (Perceived Infectability); the other assesses emotional discomfort in contexts that connote an especially high potential for pathogen transmission (Germ Aversion). Additional analyses provide evidence bearing on the convergent, discriminate, and predictive validity of each subscale.

1. Introduction

Infectious diseases have imposed a threat to human well-being for a long time. In contemporary contexts, both objective and subjective vulnerability to disease has implications for a wide range of outcomes (Ackerman et al., 2009; Curtis, Aunger, & Rabie, 2004; Fessler, Eng, & Navarrete, 2005; Fincher, Thornhill, Murray, & Schaller, 2008; Schaller & Murray, 2008). Many phenomena in the realm of social cognition are influenced by the temporary salience of disease and by individual differences in chronic concerns about disease transmission (Schaller & Duncan, 2007). These individual differences predict ethnocentric attitudes, antipathy toward individuals who are obese or physically disabled, and preferences for facial characteristics associated with good health (Faulkner, Schaller, Park, & Duncan, 2004; Navarrete & Fessler, 2006; Park, Faulkner, & Schaller, 2003; Park, Schaller, & Crandall, 2007; Welling, Conway, DeBruine, & Jones, 2007). The emerging implication is that different psychological phenomena (many of which may not be overtly disease-relevant) may be uniquely predicted by individual differences in perceived vulnerability to infectious disease.

Three different kinds of self-report instruments might be used to assess perceived vulnerability to infectious disease. Each has its limitations.

First, given that the emotion of disgust is elicited by disease-connoting cues (Curtis et al., 2004), one might use measures of disgust sensitivity as an affective indicator of perceived vulnerability to disease (e.g., Navarrete & Fessler, 2006). This empirical approach is less than ideal given that disgust sensitivity measures (Haidt, McCauley, & Rozin, 1994; Olatunji et al., 2007) assess reactions to a broad range of stimuli, only a subset of which are directly relevant to disease transmission. Also, these measures are designed to assess affective responses, but are not suited to pick up on less emotion-laden beliefs or perceptions pertaining to one's susceptibility to disease transmission.

A second set of measures comprises instruments designed to assess hypochondria and other health-relevant anxieties (e.g., Kellner, 1986; Pilowsky, 1967). These measures do assess beliefs about one's susceptibility to disease, but they tend to focus on a very broad range of potential health problems (e.g., heart disease, cancer), rather than on infectious diseases in particular. These scales are typically designed for clinical diagnostic purposes, lessening their suitability for non-clinical research.

Given the limited utility of existing self-report instruments, a new measure was designed to assess perceived vulnerability to disease (PVD). This measure assesses beliefs about personal susceptibility to the transmission of infectious diseases and emotional discomfort in the presence of potential disease transmission, and has been included in several recent investigations (Faulkner et al., 2004; Hodson & Costello, 2007; Navarrete & Fessler, 2006; Park et al., 2003, 2007; Welling et al., 2007). This research attests to the empirical utility of this self-report questionnaire. It also reveals a set of methodological inconsistencies and shortcomings. Different versions of the questionnaire have been employed (ranging from 14 to 19 items). Scoring of the questionnaire has been inconsistent. In some investigations, responses were compiled to

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produce a single overall PVD score (e.g., Faulkner et al., 2004); in other investigations, subscale scores were computed (e.g., Park et al., 2003). The PVD questionnaire has not undergone psychometric validation. Consequently, no version of the PVD questionnaire has been published in the scientific literature.

This article is designed to overcome those limitations. We provide a psychometric assessment of 19 items that comprise the longest regularly used version of the PVD questionnaire.

2. Methods and results

2.1. Item development

Nineteen items were designed to assess either general beliefs about personal susceptibility to infectious diseases or discomfort in situations in which the possibility of disease transmission was salient. These items were constructed by the first author, who solicited input and item nominations from colleagues familiar with research on disgust and infectious diseases. Approximately half the items were reverse scored. Participants responded to each item on a 7-point scale (with endpoints labelled "strongly disagree" and "strongly agree").

2.2. Item reduction and factor analysis

2.2.1. Participants and dataset

There were 1539 participants across 22 different studies. In each study, participants completed the 19-item version of the PVD questionnaire among other questionnaires and tasks. For four studies, participants were undergraduate students at the University of Groningen, in the Netherlands (n = 424; 291 female, 133 male; mean age = 20.8). For the remaining studies, participants were undergraduate students at the University of British Columbia, in Canada (n = 1117; 843 female, 272 male; mean age = 20.1). The UBC sample was ethnically diverse, including 595 participants of East Asian heritage, 353 participants of European heritage, and 167 participants from a variety of other ethnic backgrounds.

2.2.2. Inter-item correlations

Inter-item correlations for all 19 items were computed for the 1508 participants who answered every item. Results revealed that four items had unacceptably weak inter-item relationships ($|r|$s < .3; Tabachnick & Fidell, 2001). These items were removed, leaving 15 items (that all 1539 participants had completed) for further analysis.

2.2.3. Factor analyses

The 15 remaining items were subjected to parallel analysis with principal axis factoring. Results indicated that two factors should be retained based on 95-percentile of random eigenvalues. A two-factor solution (with Direct Oblimin rotation) was forced. This solution accounted for 46.3% of the variance among the 15 items after extraction, with each of the 15 items loading .4 or higher on either Factor 1 or Factor 2; no items cross-loaded. Factor 1 comprised seven items that assess beliefs about immunological functioning and personal susceptibility to infectious diseases (*Perceived Infectability*). Factor 2 included eight items that assess aversive affective responses to situations that connote a relatively high likelihood of pathogen transmission (*Germ Aversion*). Table 1 lists each of the 15 items, along with factor loadings on each factor.

The factor structure was also tested using a polychoric correlation matrix. The same items loaded with similar strength on each factor (differences in factor loadings ranged from .042 to .115). Additional factor analyses were run separately on male, female, Dutch, Canadian, East Asian Canadian, and European Canadian participants. The items loading on each factor are identical, and the strengths of the loadings are highly similar across groups, suggesting a factor structure consistent across these demographic categories.

2.2.4. Internal consistency

The 15 items showed an acceptable level of internal consistency (after reverse-scoring of items indicated in Table 1): Cronbach's alpha = .82. However, given evidence for two underlying factors, it seems appropriate to compute scores on separate subscales corresponding to the two factors. For the seven items on the Perceived Infectability factor, Cronbach's alpha = .87. For the eight items on the Germ Aversion factor, Cronbach's alpha = .74. Subscale scores are computed as the mean of all items within a factor (after reverse-scoring of indicated items). The subscale scores were only modestly correlated (r = .30), indicating the utility of computing subscale scores for purposes of prediction.

2.3. Construct validity and correlates

Subscale scores were computed as described above. Higher scores indicate greater perceived vulnerability to disease.

Table 1
Factor loadings of 15 items on the perceived vulnerability to disease (PVD) questionnaire.

	Perceived Infectability (Factor 1)	Germ Aversion (Factor 2)
In general, I am very susceptible to colds, flu and other infectious diseases. (Item 8)	**.812**	.009
I am unlikely to catch a cold, flu or other illness, even if it is 'going around'. (Item 12; reverse-scored)	– **.742**	– .031
If an illness is 'going around', I will get it. (Item 2)	**.724**	.115
My immune system protects me from most illnesses that other people get. (Item 14; reverse-scored)	– **.713**	– .073
I am more likely than the people around me to catch an infectious disease. (Item 10)	**.685**	.080
My past experiences make me believe I am not likely to get sick even when my friends are sick. (Item 5; reverse-scored)	– **.645**	– .001
I have a history of susceptibility to infectious disease. (Item 6)	**.573**	.037
I prefer to wash my hands pretty soon after shaking someone's hand. (Item 7)	.060	**.629**
I avoid using public telephones because of the risk that I may catch something from the previous user. (Item 15)	.018	**.578**
I do not like to write with a pencil someone else has obviously chewed on. (Item 4)	.006	**.551**
I dislike wearing used clothes because you do not know what the last person who wore it was like. (Item 9)	.063	**.511**
I am comfortable sharing a water bottle with a friend. (Item 3; reverse-scored)	– .008	– **.509**
It really bothers me when people sneeze without covering their mouths. (Item 1)	.037	**.470**
It does not make me anxious to be around sick people. (Item 13; reverse-scored)	– .207	– **.450**
My hands do not feel dirty after touching money. (Item 11; reverse-scored)	– .024	– **.438**

Note: Items corresponding to each of the two factors (subscales) are listed according to the strength of their factor loading. Following each item, in parentheses, are suggestions for item order when constructing a 15-item self-report questionnaire.

2.3.1. Participants and dataset

An additional 215 participants completed the 15-item version of the questionnaire. Perceived Infectability and Germ Aversion subscale scores were thus computed for a total of 1757 participants. These included 425 students from the University of Groningen (291 female, 134 male; mean age = 20.8) and 1332 from the University of British Columbia (1007 female, 325 male; mean age = 20.2). Further breakdown of the UBC sample revealed 686 participants of East Asian heritage, 438 participants of European heritage, and 208 participants from a variety of other ethnic backgrounds.

2.3.2. Gender differences

Gender differences emerged on both subscales. Compared to men, women had higher scores on both Perceived Infectability and Germ Aversion ($ts = 6.80$ and 5.70, respectively; both $ps < .001$). Means and standard deviations are presented in Table 2.

2.3.3. National and cultural differences

Table 2 also summarizes mean differences based on nationality and ethnic background. Compared to Canadian (UBC) participants, Dutch (University of Groningen) participants scored lower on both Perceived Infectability and Germ Aversion, ($ts = 7.94$ and 16.63, respectively, both $ps < .001$). Within the Canadian sample, one-way ANOVA's indicated there were ethnic differences on both PVD subscales (Perceived Infectability, $F(3, 1753) = 111.93$, $p < .001$; Germ Aversion, $F(3, 1753) = 24.50$, $p < .001$). Post hoc comparisons using Tukey's HSD test revealed that participants of East Asian background had significantly higher Perceived Infectability scores than participants of other (non-European) ethnic backgrounds, and had higher Germ Aversion scores than participants of both European and other ethnic backgrounds ($ps < .05$).

2.3.4. Assessment of convergent and discriminant validity

Within the complete set of 1757 responses, smaller subsets of participants completed additional self-report individual difference measures bearing on convergent and discriminant validity of the PVD questionnaire. Measures assessing hypochondria and other health-relevant beliefs were expected to correlate positively with PVD subscales. Measures assessing disgust sensitivity were also expected to correlate positively – especially with the Germ Avoidance subscale. In addition, we assessed relations with the Big Five personality traits, and with a wide variety of other measures on which data were available. As we discuss below, there are conceptual and/or empirical precedents to suggest that some of these additional measures may correlate with one or both PVD subscales; nevertheless, because these additional measures are conceptually distinct from both Perceived Infectability and Germ Aversion, these relations were expected to be only modest at best. Finally, we report on dispositional tendencies toward socially desirable responding; ideally, PVD subscales should be uncorrelated with this response bias.

Table 2
Mean scores on PVD subscales, illustrating gender, national, and cultural differences.

	N	Perceived Infectability	Germ Aversion
Men	458	3.08 (.98)	3.38 (1.04)
Women	1299	3.50 (1.19)	3.70 (1.02)
Dutch sample	425	3.01 (1.15)	3.00 (.82)
Canadian sample	1332	3.52 (1.12)	3.81 (1.02)
European ethnic heritage	438	3.48 (1.20)	3.55 (1.06)
East Asian ethnic heritage	686	3.59 (1.05)	4.02 (.95)
Other ethnic heritage	208	3.33 (1.12)	3.70 (.98)

Note: Standard deviations are indicated in parentheses.

2.3.5. Correlations with hypochondria and health beliefs

A small subset of participants completed the 14 item Health Anxiety Inventory (Salkovskis, Rimes, Warwick, & Clark, 2002), the 14 item Whitely Index (Pilowsky, 1967), and the 27 item Illness Attitude Scale (Ferguson & Daniel, 1995; Kellner, 1986). None of these questionnaires is specific to infectious diseases, although each assesses beliefs bearing on susceptibility to health threats, health anxiety, or hypochondriasis. Correlations between these measures and PVD subscales are presented in Table 3. All correlations are positive. All three measures correlated more strongly with the Perceived Infectability subscale than with the Germ Aversion subscale (although not significantly so, given the small sample size associated with these analyses).

2.3.6. Correlations with disgust sensitivity

Subsets of participants completed one of two disgust sensitivity measures: a 32-item questionnaire (disgust sensitivity; Haidt et al., 1994) and a revised 25-item questionnaire (disgust sensitivity – revised; Olatunji et al., 2007). Both assess emotional responses to specific elicitors. Disgust sensitivity was only weakly correlated with the PVD Perceived Infectability subscale, but more strongly correlated with the Germ Aversion subscale (see Table 3). The strongest relations were with the disgust sensitivity subscales most directly relevant to the transmission of infectious diseases (the "interpersonal disgust" subscale identified by Haidt et al. (1994), and the "contamination" subscale identified by Olatunji et al. (2007)).

2.3.7. Correlations with the Big Five personality traits

A subset of 661 participants completed a questionnaire assessing the Big Five personality traits (John & Srivastava, 1999). While none of these general personality factors correlated substantially with either PVD subscale, four of the five correlations with Germ Aversion were statistically significant, as were three of the five correlations with Perceived Infectability (see Table 3). The negative correlations between Germ Aversion and both extraversion and openness are notable, as they are conceptually consistent with previous research showing lower levels of extraversion and openness among populations with high prevalence of infectious disease (Schaller & Murray, 2008).

2.3.8. Correlations with other traits

Table 3 lists correlations between the PVD subscales and a variety of additional trait measures: the Sociosexual Orientation Inventory, which measures preferences for restricted (e.g. monogamous) versus unrestricted (e.g. promiscuous) relationships (Simpson & Gangestad, 1991), Belief in a Dangerous World (Altemeyer, 1988), Social Dominance Orientation (Pratto, Sidanius, Stallworth, & Malle, 1994), Need for Structure (Neuberg & Newsom, 1993), Need for Cognition (Cacioppo & Petty, 1982), Faith in Intuition (Epstein, Pacini, Denes-Raj, & Heier, 1996), and the Affect Intensity Measure (Larsen & Diener, 1987). Several results are worth noting. First, the negative correlations with the Sociosexual Orientation Inventory are consistent with research showing more restricted sexual behavior among populations with high prevalence of infectious disease (Schaller & Murray, 2008). Second, the relatively weak positive correlations with Belief in a Dangerous World indicate minimal overlap between PVD and perceived vulnerability to other interpersonal dangers. Third, both Faith in Intuition and Affect Intensity correlated positively with the Germ Aversion subscale, but less so with the Perceived Infectability subscale. These results are consistent with the expectation that Germ Aversion reflects a more intuitive, affect-based appraisal of disease vulnerability than Perceived Infectability.

Table 3
Correlations of the PVD subscales with other individual difference measures.

Individual difference measure	*N*	Perceived Infectability	Germ Aversion	*p*-value for difference between r's
Health Anxiety Inventory	35	.42*	.32	.62
Whitely Index	30	.37*	.56**	.28
Illness attitudes scale total	29	.72**	.57**	.28
General hypochondriacal fears and beliefs	29	.72**	.60**	.40
Thanaphobia	29	.49*	.38*	.56
Coronary heart disease and associated health habits	29	.46*	.26	.29
Symptom experience and frequency of treatment	29	.39*	.32	.70
Disgust sensitivity	983	.22**	.55**	<.001
Core	984	.17**	.41**	<.001
Interpersonal	984	.16**	.68**	<.001
Death and body envelope	983	.20**	.29**	.02
Sex	984	.15**	.38**	<.001
Disgust sensitivity – revised	214	.18**	.51**	<.001
Core	214	.20**	.46**	<.001
Animal reminder	214	.14*	.31**	.04
Contamination	214	.07	.58**	<.001
Big Five inventory				
Agreeableness	661	−.10**	−.15**	.35
Conscientiousness	661	−.11**	−.01	.04
Extraversion	661	−.06	−.16**	.04
Neuroticism	661	.17**	.17**	–
Openness	661	−.03	−.12**	.07
Sociosexual orientation	453	−.14**	−.28**	.02
Belief in Dangerous World	1315	.13*	.27*	<.001
Social Dominance Orientation	216	−.07	.28**	.06
Need for Structure	89	.16	.27**	.36
Need for Cognition	163	.00	−.09	.50
Faith in Intuition	173	−.02	.20**	.06
Affect Intensity Measure	47	.11	.34*	.25
Social Desirability	101	.00	−.02	.90

Note: Within each row, the difference in the magnitudes of the two correlations was tested against the null hypothesis (using methods described by Tabachnick and Fidell (2001)); the resulting *p*-values are tabulated in the rightmost column.
* $p < .05$.
** $p < .001$.

2.3.9. Correlations with a measure of socially desirable responding

A subset of 101 participants completed a measure assessing tendencies to respond in an inauthentic, socially desirable manner on self-report instruments (Crowne & Marlowe, 1964). Results revealed no correlation between social desirable response bias and scores on PVD subscales (see Table 3).

2.4. Predictive utility in the domain of social inference

Several published articles report results in which PVD was related to outcomes in the realm of social inference. In each, PVD scores (or PVD subscale scores) were computed somewhat differently (based on a 14-item, 18-item, or 19-item version of the PVD questionnaire). Therefore, we reanalyzed studies for which raw data were available for the 15 items identified in Table 1 to assess the differential effects of the Perceived Infectability and Germ Aversion subscales.

2.4.1. Friendships with disabled individuals

Park et al. (2003) computed two subscale scores based on an 18-item PVD questionnaire and found that both were negatively correlated with the participant-reported number of friends with physical disabilities ($rs = -.20$ and $-.22$). Subscale scores based on the 15-item PVD questionnaire produce identical results: individuals with higher scores on both Perceived Infectability and Germ Aversion report fewer friendships with disabled individuals ($rs = -.20$ and $-.21$, both $ps < .05$).

2.4.2. Explicit anti-fat attitudes

Park et al. (2007) found that dislike of fat people (a subscale of the anti-fat attitudes questionnaire; Crandall, 1994) was positively correlated with a 10-item Germ Aversion subscale ($r = .25$). This relationship remained essentially unchanged when employing the 8-item Germ Aversion subscale ($r = .24$, $p = .001$). We also found that the 8-item Germ Aversion subscale is positively correlated with another subscale of the anti-fat attitudes questionnaire – fear of becoming fat oneself ($r = .26$, $p < .000$). The Perceived Infectability subscale showed no meaningful relationship with these anti-fat attitudes ($rs = .05$ and $.08$, $ps \geqslant .14$).

2.4.3. Explicit attitudes toward immigrants

Faulkner et al. (2004) reported four studies documenting a relationship between PVD and xenophobic responses to subjectively foreign outgroups. The overall PVD score was computed from 14 self-report items. For one study (Study 4), participants actually completed a longer questionnaire that included all 15 items in Table 1. Our reanalysis revealed that the reported relationship between PVD and pro-immigrant attitudes ($r = -.40$) was due entirely to the strong negative relationship between the 8-item Germ Aversion subscale and pro-immigration attitudes ($r = -.48$, $p = .001$); the 7-item Perceived Infectability subscale was not related to pro-immigration attitudes ($r = .03$, $p = .84$).

2.4.4. Implicit negative associations with physical disability

Park et al. (2003) employed a computer-based reaction-time task to assess the extent to which physically disabled individuals were implicitly associated with aversive semantic concepts. Among European participants (but not among East Asian participants), scores on a 10-item Germ Aversion subscale were related to a tendency to implicitly associate physical disability with negative semantic concepts ($r = .38$). Our reanalysis using the 8-item Germ Aversion subscale produced the same result ($r = .35$, $p = .06$). In contrast, the Perceived Infectability subscale showed

no relation to implicit negative associations with physical disability ($r = .08$, $p = .68$).

2.4.5. Implicit ageism

One additional result reveals an outcome in which Perceived Infectability is uniquely predictive. Employing methods modeled after those of Park et al. (2003), Duncan and Schaller (submitted for publication) employed a computer-based reaction-time task to assess implicit ageism – the extent to which elderly adults are implicitly associated with negative semantic concepts. Results revealed that, among European participants for whom pathogen transmission was made temporarily salient by a slide show manipulation (but not among East Asian participants who watched the same slide show), the Perceived Infectability subscale strongly predicted implicit ageism ($r = .56$, $p < .05$). In contrast, there was no meaningful effect of Germ Aversion ($r = -.26$, $p = .35$).

3. Discussion

These analyses represent the first psychometric evaluation of an instrument that has been used across a variety of recent investigations in different research labs (e.g., Faulkner et al., 2004; Hodson & Costello, 2007; Navarrete & Fessler, 2006; Park et al., 2007; Welling et al., 2007). The results reveal two conceptually distinct factors measured reliably by 15 items. One factor (measured by seven items) assesses individuals' beliefs pertaining to their susceptibility to infectious diseases. The corresponding subscale (Perceived Infectability) correlates relatively highly with measures of hypochondria and health anxiety, but is distinct in two important ways. First, whereas other health anxiety measures assess beliefs about existing health status, Perceived Infectability assesses beliefs about vulnerability to future health problems. Second, whereas other health anxiety measures assess beliefs about diverse health problems, Perceived Infectability is specific to infectious diseases. The second factor (measured by eight items) assesses individuals' discomfort in situations that connote an increased likelihood for the transmission of pathogens. The corresponding subscale (Germ Aversion) is moderately correlated with measures assessing intuitive appraisal and emotional reactivity, and correlates relatively highly with measures that assess sensitivity to disgust – the emotional response that is linked to infectious disease avoidance (Curtis et al., 2004). Germ Aversion is not isomorphic with disgust sensitivity. Whereas disgust sensitivity measures assess emotional responses to a broad range of potentially disgust-arousing circumstances, Germ Aversion is specific to situations connoting the potential transmission of infectious diseases.

Given the conceptual distinction between the subscales, it's not surprising that they are only modestly intercorrelated. While one could compute an overall index of perceived vulnerability to disease (PVD), more nuanced predictions may be attained by computing the separate subscale scores. As summarized above, many phenomena tend to be predicted by one or the other, but not both. Within the domain of social inference, Germ Aversion predicts responses rooted in intuitive appraisals of disease transmission risk, whereas Perceived Infectability predicts responses informed by more rational appraisals. This distinction is consistent with evidence that Germ Aversion more strongly predicts implicit negative associations with individuals characterized by morphological anomalies (e.g., Park et al., 2003), whereas Perceived Infectability more strongly predicts implicit negative associations with individuals who tend to be characterized by diminished immunocompetence (e.g., the elderly; Duncan & Schaller, submitted for publication).

Additional questions and issues remain. It is not yet clear how best to interpret gender, national, and cultural differences on the PVD subscales. Although the gender differences are broadly consistent with gender differences in disgust sensitivity, and the cultural differences are broadly consistent with geographical differences in the prevalence of infectious diseases, the meanings of these differences, and their implications, remain to be explored. Additional research must be done to further explore the range of phenomena that might be predicted by the constructs assessed by the PVD scale.

4. Conclusions

A surge of empirical research indicates that the threat posed by infectious diseases has implications for psychological outcomes. This research highlights the scientific value offered by an instrument that can specifically and reliably assess individual differences in perceived vulnerability to infectious disease. The perceived vulnerability to disease (PVD) questionnaire attempts to provide such an instrument. The empirical merit of the PVD questionnaire is suggested by its recent employment in multiple research labs. The PVD questionnaire had its utility constrained by the fact that the questionnaire had never previously been subjected to careful psychometric scrutiny, and that no version of the questionnaire had ever been archived in the scientific literature. We hope that this article helps to address those issues.

Ethical statement

The rights of all participants in the studies were protected, and the studies carried out under the guidelines approved by the Behavioral Research Ethics Boards of the respective institutions.

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