

Sex, germs, and health

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Sex, germs, and health: pathogen-avoidance motives and health-protective behaviour

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Objective: Recent work suggests that the psychology of pathogen-avoidance has wide-reaching effects on how people interact with the world. These processes – part of what has been referred to as the behavioural immune system – are, in a way, our ‘evolved’ health psychology. However, scholars have scarcely investigated how the behavioural immune system relates to health-protective behaviours. The current research attempts to fill this gap.

Design: Across two cross-sectional studies ($N = 386$ and 470 , respectively), we examined the relationship between pathogen-avoidance motives and health-protective behaviour.

Outcome Measures: The studies used self-reported measures of attitude and intention as indicators of health-protective behaviour.

Results: Data collected in Study 1 revealed that pathogen-avoidance motivation related to participants’ attitude and intention towards sexually transmitted infections screening. High levels of pathogen-avoidance motivation were also related to having had fewer sexual partners, which partially mediated the effect of pathogen-avoidance variables on testing motivation. Study 2 extended these findings by showing moderate associations between pathogen-avoidance motivation and a broad range of health-protective behaviours, including but not limited to pathogen-related health concerns.

Conclusion: We argue that understanding and targeting pathogen-avoidance psychology can add novel and important understanding of health-protective behaviour.

Keywords: pathogen-avoidance; pathogen disgust; behavioural immune system; health-protective behaviour; STI screening; sexual health

Viruses and bacteria have infected multicellular organisms for millions of years, and their consequences have led to the evolution of complex defence systems, such as the innate and adaptive immune system. Researchers have recently begun to detail the aspects of our psychology that act as additional, first line of defence against pathogens (e.g. Curtis & Aunger, 2011; Curtis, 2013; Tybur, Lieberman, Kurzban, & DeScioli, 2013) – these psychological defenses have been described as the ‘behavioural’ immune system (Schaller, 2011; Schaller & Park, 2011).

Despite the strong recent increase in behavioural immune system research (e.g. Schaller, 2011, 2014; Tybur, Frankenhuis, & Pollet, 2014), empirical research into how

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to connect the behavioural immune system to health promotion questions remains scarce. Here we aim to fill this gap by reporting two studies that test whether behavioural immune system principles can help explain health-protective behaviour. Specifically, we investigate how behavioural immune system processes might be used to understand health-protective behaviour, particularly those relevant to sexual health.

Several lines of research have focused on better understanding what leads to behaviours that prevent sexually transmitted infections (STI), including condom-use (e.g. Albarracín, Johnson, Fishbein, & Muellerleile, 2001; Bryan, Aiken, & West, 1996) and post-coital prophylactic behaviours, such as screening for STI (e.g. Lorenc et al., 2011; Mevissen, Ruiter, Meertens, Zimbile, & Schaalma, 2011). Despite progress in our understanding of the determinants of health-protective behaviours, the consequences of infectious disease remain a significant problem.

Much of the research on STI prevention is guided by social cognitive theories, such as the theory of planned behaviour (Ajzen, 1985, 1991; Godin & Kok, 1996) and the health belief model (Janz & Becker, 1984; Rosenstock, 1974). These models propose that personal beliefs (e.g. those related to risk assessment and personal abilities) are the primary determinants of health behaviour. Implicit in such models is the assumption that people have conscious access to the most important psychological factors influencing health behaviour. Although these approaches to health-protective behaviour have been useful in predicting behaviour, and identifying targets for interventions, a number of additional, lesser examined motivational processes might also underlie health behaviour. We propose that pathogen-avoidance motivations are among these.

Mechanisms underlying pathogen-avoidance

Since infectious microbes are too small to be seen directly, the behavioural immune system has been shaped to monitor for and respond to cues that reliably correlate with the presence of pathogens (Schaller & Park, 2011). A broad range of perceptual cues – including visual, olfactory, gustatory and tactile cues – might suggest that pathogens are present, and hence evoke a pathogen-avoidance motivational state, such as disgust (see Tybur et al., 2013). Some recent work suggests that these motivations – either at a trait or state level – can influence health-promoting behaviours. For example, Tybur, Bryan, Magnan, and Hooper (2011) invited participants into a lab that was sprayed with an odour similar to those associated with pathogen sources. The authors hypothesised that this olfactory cue to pathogens would (implicitly) motivate prophylactic behaviour – specifically, that it would increase participants' intention to use, buy and discuss the use of condoms in future sexual encounters. Results were consistent with this hypothesis – participants in the pathogen prime condition reported greater condom use intentions than participants in a control condition.

Complementing these findings, Meertens, Branković, Ruiter, Lohstroh, and Schaalma (2013) examined the effect of the physical environment on participants' beliefs about susceptibility to STI. They found that participants who imagined waking up in a dirty room after a one-night stand judged their susceptibility to STI to be higher than did participants who imagined themselves waking up in a clean environment after a one-night stand. Participants imagining the dirty room also considered the odds of engaging in unsafe casual sex in the future significantly lower.

Sexual behaviour and trait aversion to pathogens

Both of the above examples concerned sexual behaviour. This is perhaps not surprising, since sexual behaviour with another person reliably put a person at risk of pathogen infections. Intercourse is a major source of risk for bacterial infections such as Chlamydia and Gonorrhoea, and viral infections such as HIV and herpes. Further, the close physical contact that co-occurs with sexual intercourse puts individuals at risk for infection via pathogens transmitted through nonsexual fluids (e.g. saliva and sweat), simply because of physical proximity and contact with a partner. These risks might underlie some of the main motivations to *not* engage in sexual behaviours (e.g. Patrick, Maggs, Cooper, & Lee, 2011). Naturally, there are many *benefits* to sexual behaviour too, such as procreation and experiencing pleasure and intimacy – benefits that engender strong motivations to engage in sexual behaviour (e.g. Hill & Preston, 1996). Indeed, sexual and pathogen-avoidance motives are likely antagonistically related to each other. That is, relevant goal-states, such as pathogen-avoidance and a desire to experience sexual pleasure may act as opposing psychological forces in motivating behaviour.

For example, Borg and De Jong (2012) observed a negative relationship between disgust and feelings of sexual arousal. Such results illustrate the interplay between two competing motivational states; when sexual arousal is high, disgust responses related to pathogen threat may decrease. Additional research has focused on trait variability in pathogen-avoidance and its relationship with sexual behaviour (Duncan, Schaller, & Park, 2009; Gangestad & Grebe, 2014; Tybur, Inbar, Güler, & Molho, 2015; Tybur, Lieberman, & Griskevicius, 2009). Some of this work has demonstrated that individuals who have higher trait level pathogen-avoidance are less inclined to engage in sex with multiple partners, which is a key risk factor for acquiring an infectious disease (e.g. Joffe et al., 1992). With regard to sexual health, researchers observed a reliable negative association between trait pathogen-avoidance tendencies and motivations to have sex with multiple partners (e.g. Duncan et al., 2009; Murray, Jones, & Schaller, 2013; Tybur et al., 2015). This suggests that *trait* variation in pathogen-avoidance might affect the implicit cost-benefit analysis involved in the decision to have casual sex. Specifically, people with an active behavioural immune system might ‘judge’ the costs of casual sex to be higher than people with a less active behavioural immune system, and thus would have less casual sex and perceive a higher need for health-protective behaviour in risky situations (e.g. STI testing after unsafe sex). Overall, we assumed that a basic motivation for pathogen-avoidance might influence attitude and intention towards health-protective behaviour, and we tested these relationships in two cross-sectional survey studies.

Study 1

In our first study, we examined how individual differences in pathogen-avoidance motivations relate to testing for STI.¹ We examined whether individuals scoring higher on pathogen-avoidance motivation not only have had fewer casual sex partners – thus limiting the chances for pathogen transmission – but whether they are also more inclined to be screened for STI after an act of unprotected sexual intercourse. We expected that history of casual sex is likely a direct predictor of health-protective attitude and intention. Moreover, considering earlier work that directly related pathogen-avoidance with

sexual behaviour (e.g. Tybur et al., 2015), we expected history of casual sex to mediate the relationship between pathogen-avoidance and health-protective attitude and intention. Inclinations towards testing for STI were operationalised using measures of attitude and intention, as is commonplace in many behaviour prediction models (e.g. Ajzen, 1985, 1991). Our hypotheses were as follows:

- (1) Pathogen-avoidance motivation correlates positively with attitude and intention towards being screened for STI after an act of unsafe sex.
- (2) Pathogen-avoidance motivation correlates with fewer self-reported past casual sexual contacts.
- (3) The relationship between pathogen-avoidance and intention towards STI screening is mediated by attitude and history of casual sex.

Methods

Participants and selection procedure

Using a crowdsourcing platform, Amazon Mechanical Turk (for an evaluation, see Buhrmester, Kwang, & Gosling, 2011) participants from the US were invited via an advertisement on Amazon.com to participate in the current study. We limited our recruitment to men and women aged 18–27 years who were not in a romantic relationship. We selected this age group since it presents an at-risk population for STI and because of a larger variance in sexual behaviour compared to older populations. A total of 752 complete responses to the survey were recorded. Duplicate responses were determined by IP-matching and exact data matches. Only initial responses from users to the survey were maintained in the data-set.

After exclusion of non-single participants ($N = 161$), duplicate respondents ($N = 95$), exclusion of individuals who did not adequately respond to an integrated attentive reading check² ($N = 79$), and participants that did not meet our age criterion ($N = 31$), our final sample contained a total of $N = 386$ participants, including 228 men ($M_{\text{age}} = 23.8$) and 158 women ($M_{\text{age}} = 23.6$).

Materials and measures

Sociosexual orientation inventory

We measured participants' history of engaging in casual sex using the Revised Sociosexual Orientation inventory (SOI-R; Penke & Asendorpf, 2008). The SOI-R includes nine items, measured on 9-point Likert scales, assumed to be indicators of three factors: (1) desire to have casual sex, (2) attitude towards having casual sex and (3) actual history of having casual sex. Since we are mainly interested in sexual behaviour, as this is the actual risk factor for disease contraction, we only included the *behaviour facet* of the SOI-R in our analyses.

Pathogen-avoidance

We measured individual differences in pathogen-avoidance using the Perceived Vulnerability to Disease Scale (PVD; Duncan et al., 2009), a 15-item scale with two

subscales: Germ aversion and Perceived Infectability. The Germ Aversion facet of the PVD was used as a proxy of pathogen-avoidance motivation in our models.³ The eight germ aversion items measure a respondent's aversion towards pathogen-related stimuli (e.g. *I prefer to wash my hands pretty soon after shaking someone's hand.*). All items were measured on a 7-point Likert scale (1 = absolutely disagree, 7 = absolutely agree).

Intention and attitude

Both intentions and attitudes were measured conditionally, that is, participants were asked to rate questions pertaining to these constructs hypothetically, i.e. 'if they would have had unsafe sex in the next week'. We used three items to assess inclination towards testing for STI, each of which were measured on 7-point Likert scales (1 = very unlikely, 7 = very likely). The three intention items were framed over different time periods: 'If I had unsafe sex in the next week, I would take an sexually-transmitted diseases (STD)-test *within a month*'; the italicised time frame replaced in the other items with three months and half a year, respectively. Attitudes were also measured using three indicator items, again with a 7-point Likert scales. Participants indicated how useful, important and appropriate they considered getting tested for STI should they have unsafe sex during the next week.

Procedure

Approval to conduct this study was obtained from the Ethics Committee of Psychology at Maastricht University. After enrolling in the study, participants were directed to the Qualtrics website (<http://www.qualtrics.com>), where they were asked to provide informed consent. Participants then answered some demographic questions and some additional questions not pertinent to the current investigation. Next, participants completed the PVD and the SOI-R. Participants then indicated their attitude towards and intention to be tested for STI. Finally, participants were thanked for their participation, informed about the study hypotheses and paid.

Statistical analysis

Data were analysed with a structural equation modelling approach using Mplus software, version 7.11 (Muthén & Muthén, 1998–2012). First, we specified a measurement model for the hypothesised constructs. We subsequently modelled the structural relationships between these latent variables. In addition to estimating path coefficients, we report several fit indices for these models: (a) χ^2 test of model fit, (b) the root mean square error of approximation (RMSEA), (c) a standardised root mean square residual (SRMR) and (d) a comparative fit index (CFI). We interpret model fit as adequate or good when RMSEA $\leq .08$ or $\leq .05$, respectively, and SRMR $\leq .08$, and CFI $\geq .90$ or $\geq .95$, respectively (Hu & Bentler, 1999).

Measurement model

Indicator items were specified to load on their expected latent variables, that is, the items from the previously validated germ aversion facet (Duncan et al., 2009) and the SOI (Penke & Asendorpf, 2008). The indicator items designed to measure testing

attitude ($k = 3$) and intention ($k = 3$) were specified to load on intention to test, and attitude towards testing latent variables.

Structural models

The models take as starting point earlier theory based findings on the relationship between germ aversion and sociosexuality. Hence, we modelled a relationship between pathogen-avoidance motivation and history of casual sex. We also modelled effects of pathogen-avoidance on intention to test, via attitude towards STI screening. An additional path was specified between past sexual behaviour and attitude towards testing. The mediating effect of attitude between a given background variable on intention is common in the theory of planned behaviour (Ajzen, 1985, 1991), and was thus a priori specified in our models.

Results and discussion

To determine the appropriate estimation method for our model, we first examined whether our variables satisfied the assumptions of univariate and multivariate normality. These assumptions were not met for our main outcome variables, attitude and intention, so a robust maximum likelihood estimation (Yuan–Bentler scaled χ^2) procedure was used in all subsequent models. There were no missing data in our sample.

We thus used Germ Aversion facet items as indicators of a latent variable for pathogen-avoidance motivation. Analysis of a complete measurement model confirmed our expectations about the underlying factor structure, including latent variables for the germ aversion, sexual behaviour, attitude and intention items, $\chi^2 = 191.951$, $df = 111$, $p < .001$ (CFI = 0.967, RMSEA = 0.043, SRMR = 0.049). The only *post hoc* modification to our measurement model was the inclusion of residual covariances between the three indicator items loading on the intention to test construct (see the supplementary materials for observed correlations between the latent variables). Next, we imposed the predicted structural relations on the model (see Figure 1). Here, we specified two paths running from pathogen-avoidance scores to STI testing intention, one path from pathogen-avoidance via attitude towards testing intention. The other path ran from pathogen-avoidance to history of casual sex, and again on intention to test via attitude. We then tested the significance of the indirect effect of pathogen-avoidance on attitudes to test through history of casual sex, using bootstrapped ($n = 5000$) standard errors. This indirect effect through history of casual sex was significant, $b = .035$, $z = 2.196$, $p = .028$; 95% BCI [.004; .067]. Additionally, the indirect effects of pathogen-avoidance on intentions to test for STI (via either history of casual sex or testing attitude) were also significant, $b = .024$, $z = 2.149$, $p = .032$; 95% BCI [.002; .045].

These results suggest that pathogen-avoidance motivation might influence health-protective behaviour by (1) decreasing overall sexual behaviour, i.e. having less casual sexual partners, and (2) by leading to increased attitudes and higher intentions to get tested after an act of unsafe sex. Specifically, the results show that the more pathogen avoidant participants were, the fewer sexual partners they report having. Additionally, higher scores on our pathogen-avoidance measure related both directly and indirectly (via history of casual sex) to more positive attitudes and intentions towards getting tested for STI. These results are in line with previous work on pathogen-avoidance and

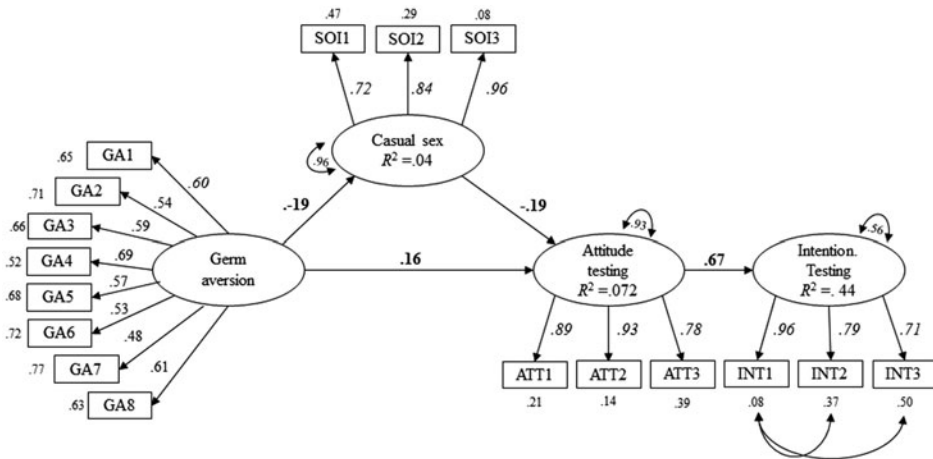


Figure 1. Measurement and structural latent variable model of pathogen-avoidance and STI testing intention. (Study 1). Bold coefficients indicate regression coefficients. R^2 – values, error terms and disturbances are provided for the latent variables. All parameter estimates are provided in a fully standardised format (STYX). Italicised coefficients indicate factor loadings. Abbreviations: GA1–GA8 = Germ Aversion indicators; SOI1-3 = Sociosexual behaviour indicators; ATT1-3 = STI testing attitude indicators; INT1-3 = STI testing intention indicators. Fit indices: $\chi^2 = 192.30$, $df = 113$, $p < .001$; CFI = 0.968, RMSEA = 0.043, SRMR = 0.049.

health behaviour. Further, similar to work on *state* induced pathogen-avoidance (e.g. Meertens et al., 2013; Tybur et al., 2011), results suggest that individual differences in *trait* pathogen-avoidance tendency appear to be important for understanding sexual behaviour itself, and perhaps more relevant, also prophylactic behaviour after an act of unsafe sex.

Study 2

Study 1 targeted one specific health-protective behaviour: testing for STI. However, it is possible that pathogen-avoidance processes might have broader effects on health-protective behaviours, and not only relate to intention to test for STI. In this study, we therefore examined whether pathogen-avoidance is only important for the regulation of pathogen-related (infectious) disease, or whether it also regulates health-protective behaviours that are not necessarily related to the avoidance of pathogens. Therefore, in Study 2, we aimed to replicate and extend the model from Study 1 by investigating whether pathogen-avoidance relates only to those health behaviours related to infectious disease vs. health behaviours for non-contagious diseases.

To this end, in addition to measures of attitude and intention towards getting tested for STI, we included attitudes and intentions towards a variety of testing/screening behaviours related to a broad range of health concerns. We differentiated between *pathogen-related* screening behaviour (e.g. would you get screened for infections after being bitten by a stray dog) and more intention to screen for ostensibly *pathogen-unrelated* conditions (e.g. would you go to see a doctor if you notice a suspicious mole on your arm). Similar to Study 1, these health behaviours were operationalised with

measures of attitude and intention. Moreover, in Study 2, we included an additional, complementary measure of pathogen-avoidance motivation, the pathogen disgust facet from the Three Domain Disgust Scale (Tybur et al., 2009). Our hypotheses for Study 2 were as follows:

- (1) Pathogen-related and pathogen-unrelated screening attitude and intention constructs are distinct, as evidenced by a confirmatory higher order factor analysis.
- (2) History of casual sex relates to pathogen-related attitudes and intentions only but not to pathogen-unrelated screening attitudes and intentions.
- (3) Pathogen-avoidance motivation directly influences attitudes towards health screening behaviour, and especially those behaviours where the health risk relates to pathogens contagion.
- (4) The relationship between pathogen-avoidance and health-protective attitudes and intentions is mediated by history of casual sex.

Participants and selection procedure

As in Study 1, we used Amazon Mechanical Turk to recruit participants. Selection criteria were identical to Study 1. A total of 627 complete responses to the survey were recorded. After exclusion of non-single participants ($N = 119$), and participants that did not meet our age criterion ($N = 38$), our sample contained a total of $N = 470$ participants, including $N = 236$ men ($M_{\text{age}} = 23.4$) and $N = 234$ women ($M_{\text{age}} = 22.6$).

Materials and measures

Attitudes and intentions

Participants' attitudes and intentions were assessed in a manner similar to that employed in Study 1, with three items used as indicators for each health issue. Participants were asked to rate their attitudes towards the following pathogen-related health concerns: (1) 'If I had unsafe sex, I think testing for STI would be ...' (2) 'If I had been bitten by a stray dog, I think testing for rabies would be ...', (3) 'If I heard on the local news that the flu was going around, I think getting a flu shot would be ...'. Each measure used three (7-point) semantic differentials (useful, important, appropriate) to assess these attitudes.

Participants also rated attitudes towards testing for the following ostensibly pathogen-unrelated medical conditions: (1) 'If I had noticed a new, unusual looking mole, taking a test for skin cancer would be ...', (2) 'If I felt constantly tired for over a month, getting tested for blood disorders (e.g. an iron-deficiency) would be...' and (3) 'If I had repeated, painful headaches for over a week, going to see a doctor for it would be...'. The intention questions of all six behaviours were phrased similarly to Study 1 as well, but with time frames 'within the next week', 'within the next month' and 'within the next three months'.

pathogen-avoidance

Identical to Study 1, we included the PVD scale. We also included the pathogen disgust facet of the TDDS (Tybur et al., 2009). For this instrument, participants were asked to

Table 1. Model fit statistics for the higher order confirmatory factor analyses (Study 2).

Measure	Model	^a Obs	YB- χ^2	df	CFI	RMSEA	90% CI	SRMR	RES ^{cov}
Attitudes	Congeneric	18	259.21*	126	0.963	0.047	[0.039; 0.056]	0.039	3
	Discriminant	18	258.35*	125	0.963	0.048	[0.039; 0.056]	0.038	3
Intentions	Congeneric	18	367.94*	119	0.933	0.067	[0.059; 0.075]	0.068	10
	Discriminant	18	361.79*	118	0.934	0.066	[0.059; 0.074]	0.066	10
Casual sex PA	SOI-B	3	16.45*	2	0.948	0.124	[0.073; 0.182]	0.049	0
	GA, PD	15	207.93*	86	0.900	0.055	[0.045; 0.064]	0.057	3
All	Complete model	54	2497.46*	1328	0.918	0.043	[0.041; 0.046]	0.071	29

Notes: PA = pathogen-avoidance; GA = Germ aversion scale; PD = Pathogen disgust scale; SOI-B = Sociosexual orientation behaviour facet. Yuan-Bentler rescaled χ^2 ; df = model degrees of freedom; CFI = comparative fit index; RMSEA = root-mean squared error of approximation; SRMR = standardised root-mean squared residual; RES^{cov} = residual covariances in model.
^aobserved variable count,
 * $p < .01$.

indicate how disgusting they find seven items (e.g. Stepping in dog poop) on a 0 (not at all disgusting) to 6 (extremely disgusting) scale. In this study, we operationalised pathogen-avoidance motivation using both the germ aversion scale and the pathogen disgust facet.

Procedure

The design was largely similar to that of Study 1, except that we included six distinctive health-protective behaviours, three of which related to pathogenic diseases, and three of which related to non-pathogenic health issues. The question groups pertaining to each of these behaviours were presented in a random order. Moreover, to prevent unwanted priming effects of our pathogen-avoidance measures on the dependent variables, participants first filled out questions pertaining to attitude and intention, followed by the pathogen-avoidance motivation measures. At the end of the survey, we asked participants whether they were familiar with the health problems we asked about (e.g. rabies, iron-deficiency), and scores were replaced with missing values if participants indicated not being familiar with the meaning of a health issue. Missing data for the variables were all under 10%.

Statistical analysis

Our structural equation modelling approach was the same as previously reported. First, we conducted confirmatory factor analysis (CFA) to determine the adequacy of the scales used in this study. Given that we had missing data (maximum of 10%), and our variables were skewed, we opted to use a robust maximum-likelihood estimation (Yuan–Bentler scaled χ^2). Because we had two convergent measures of pathogen-avoidance motivations in this study, we specified a higher order factor ('pathogen-avoidance') and tested whether both measured a similar high-order construct. Given that we included six distinctive behaviours (pathogen related vs. pathogen unrelated) we also specified another two higher order factors in our measurement model for attitudes, (1) a pathogen-related attitudes factor, using the *STI*, *dog bite* and *flu shot* constructs as indicators, and (2) a pathogen-unrelated factor, using the *mole*, *iron-deficiency* and *head-ache* constructs. The same hierarchical structure in the factors was specified for intentions to test. First we compared a discriminant model (first-order factors arranged under two higher order factors: pathogen-related vs. pathogen-unrelated variables) with a congeneric model (all behaviours loading on one second-order construct). We then proceeded in two steps, first by replicating our previously reported model, and second by extending the structural model with the additional health-protective behaviours. Finally, we tested the indirect effects in our structural model using bootstrapped ($n = 5000$) standard errors to construct 95% confidence intervals.

Results and discussion

Measurement model

The results of our CFA analyses, including a comparison of congeneric vs. discriminant structures for attitudes and intentions are reported in Table 1. Although both congeneric as discriminant factor structures fit equally well, we opted to proceed to test structural

relationships by maintaining a distinction between pathogen-related and pathogen-unrelated conditions. The germ aversion and pathogen disgust scales loaded strongly on a common pathogen-avoidance factor, suggested by high factor loadings on the second-order factor. The overall measurement model fit was acceptable (see Table 1).

Structural model

We specified an initial model to replicate the relationship between pathogen-avoidance and attitude/intention towards getting screened for STI after an act of unsafe sex. This model was conceptually identical to the one reported in Study 1. Results indicate that our previously reported model replicates well in this sample (see supplementary materials for the replication of the STI model).

Next, we tested our model including all health-protective behaviours. We specified a model in which pathogen-avoidance predicted sexual behaviour and both the pathogen-related and pathogen-unrelated health behaviours (see Figure 2). Attitudes were specified to be the direct predictor of intentions, as described in Study 1. Results indicate that, in accordance with expectations, pathogen-avoidance predicted intention to test for pathogen-related health issues via attitude and also via history of casual sex. Contrary to expectation, however, pathogen-unrelated intentions were predicted equally strong by pathogen-avoidance, again via attitudes and sexual behaviour. Notably, though, the indirect effects from pathogen-avoidance on intentions through sexual behaviour were descriptively stronger for pathogen-related testing intentions. The indirect effects of pathogen-avoidance motivations on intentions to test, both pathogen-related as unrelated, were also tested for significance. There were indirect effects through attitudes on both the higher order intention constructs. However, the indirect effects through both sexual behaviour and attitudes were not statistically significant. Table 2 depicts the observed correlations, and tests of mediation are included in the supplementary materials.

General discussion

The aim of the current research was to investigate how motivations to avoid pathogens relate to health-protective behaviours. Results from Study 1 revealed that participants'

Table 2. Observed correlation matrix of the latent variables for the full-SEM model (Study 2).

Measure	1	2	3	4	5	6	7	8
1. Germ aversion	–							
2. Pathogen Disgust	.56	–						
3. Sexual behaviour	–.14	–.16	–					
4. Intention PR	.26	.29	–.22	–				
5. Intention PU	.19	.21	–.12	.92	–			
6. Attitudes PR	.35	.38	–.29	.76	.66	–		
7. Attitudes PU	.28	.31	–.17	.74	.68	.97	–	
8. PA	.72	.79	–.20	.36	.26	.48	.39	–

Notes: All measures except PA represent first-order constructs. For the attitudes and intention constructs only second-order factors are correlated. Abbreviations: PA = pathogen-avoidance; PR = Pathogen related; PU = Pathogen unrelated.

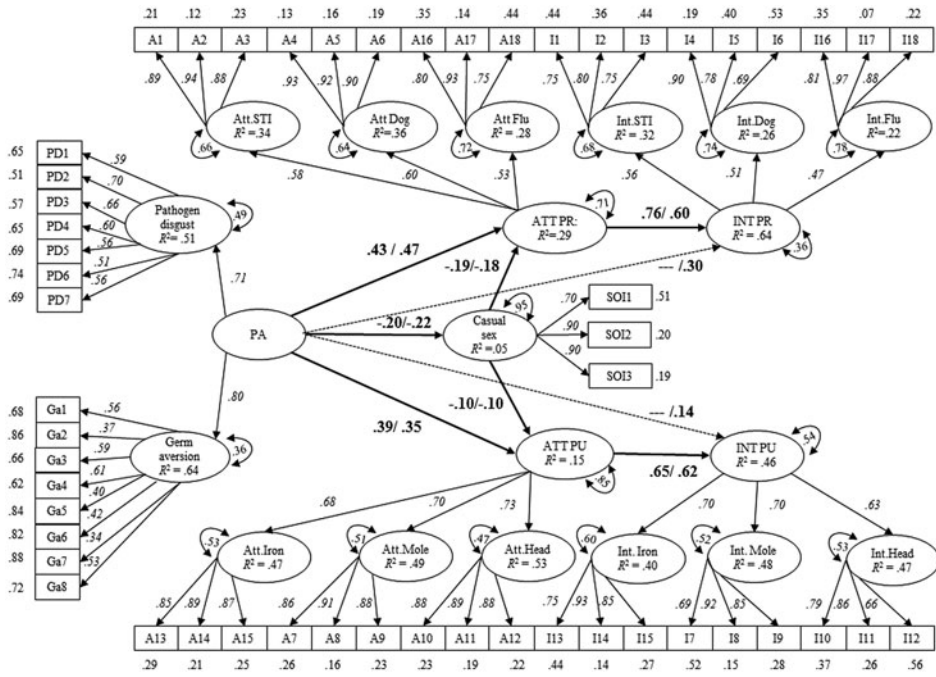


Figure 2. Measurement and structural latent variable model of pathogen-avoidance and health-protective intentions (Study 2). The diagram represents two structural models, the first includes freely estimated direct effects of pathogen-avoidance on intention (coefficients right of the slash) and the second in which direct effects are constrained to zero (weights left of the slash). Bold coefficients indicate regression coefficients. Italicised coefficients indicate factor loadings. R^2 – values, error terms and disturbances are provided for the unrestricted model including direct effects. All parameter estimates are provided in a fully standardised format (STYX). Abbreviations: PA = Pathogen-avoidance motivation; Attitudes PR = Pathogen related testing attitudes; Attitudes PU = Pathogen unrelated attitudes; GA1–GA8 = Germ Aversion Scale; PD1–PD7 = Pathogen disgust scale; SOI1–3 = Sociosexuality behaviour scale. Fit indices full model: $\chi^2 = 2502.83^*$, $df = 1332$, $p < .001$; CFI = 0.918, RMSEA = 0.043, SRMR = 0.071. Fit indices restricted model: $\chi^2 = 2515.63^*$, $df = 1334$, $p < .001$; CFI = 0.917, RMSEA = 0.043, SRMR = 0.073. $\Delta\chi^2 (2, N = 470) = 12.80$, $p = .002$ (Satorra–Bentler scaled).

intentions to be tested for STI were predicted by pathogen-avoidance variables. Moreover, attitudes towards testing and number of sexual partners mediated the effect of pathogen-avoidance on testing motivations. Study 2 replicated and extended these findings by showing moderate associations between pathogen-avoidance and a broad range of health-protective behaviours, including but not limited to pathogen-related diseases. In addition, a comparison of the explained variance in pathogen-related vs. pathogen-unrelated health-protective intentions (Study 2) indicated that 58% of the variance in pathogen-related intentions were explained by the variables in our model vs. 46% of the variance in pathogen-unrelated intentions. Our models also suggest that pathogen-avoidance motivations explain unique variance in testing intentions, although a significant amount of the variance in testing intentions was explained through attitudes.

The first main finding we reported across two studies, a negative association between pathogen-avoidance and sexual behaviour, is in line with previous work. To understand variance in pathogen-avoidance tendencies, researchers (e.g. Murray et al., 2013; Schaller & Park, 2011; Tybur et al., 2013) have considered trade-offs involved in the regulation of sexual behaviours. On the one hand, individuals are motivated to have sex, often in the absence of a monogamous relationship. On the other hand, sexual intercourse is a major risk factor for pathogen transmission, and some of the implicit *sexual avoidance* motivations might have roots in pathogen-avoidance motives. This interplay between competing motives is illustrated in our studies: participants who are more pathogen-avoidant had a history of fewer different sex-partners. Thus, the results suggest that differences in sexual behaviour might be partly linked to pathogen-avoidance tendencies.

Our results further suggest that pathogen-avoidance motivations have two complementary health-protective effects: first, by reducing the inclination towards casual sex, and second, by increasing attitudes and intentions towards health screening behaviour. Interestingly, higher levels of pathogen-avoidance tendencies were strongly linked to increased attitudes and intentions towards testing for STI, as well as to a range of both pathogen-related and unrelated screening behaviours. This implies that individuals with stronger motivations to avoid pathogens are more protective of their health in general.

Initially, it is not straightforward to assume that high levels of pathogen-avoidance should be associated with more positive evaluations towards getting screened for concerns such as a suspicious mole or a constant headache. Yet, our results speak for a *generalized* relationship between pathogen-avoidance and health-protective behaviours – although a substantially smaller percentage of variance was explained in pathogen-unrelated testing intentions. Although these results were not completely in line with our hypotheses, they do not necessarily argue against the view that the behavioural immune system is specialised for managing the threat of pathogen transmission. Rather, the generalised tendency to get screened – whether the health concern relates to pathogens or not – might indicate that pathogen-avoidance motives guide decisions about health even for conditions not directly associable with pathogens (see also Schaller & Park, 2011). Thus, results here may suggest that individuals with higher pathogen-avoidance motivation are biased to treat symptoms potentially indicative of contagion – whether this be a frequent headache, a mole, a dog bite or unsafe sexual behaviour – as valid and worthy of treatment. In short, variation in pathogen-avoidance seems to relate to a generalised tendency to act more health-protectively, suggesting that pathogen-avoidant individuals might worry more about their health in general.

Our analysis of mediated effects of pathogen-avoidance on testing intentions also indicated an indirect effect through past sexual behaviour on attitudes towards testing for pathogen-related disease (this approached significance), but the indirect effect towards pathogen-unrelated conditions was descriptively smaller. The negative relationship between history of casual sex and testing attitudes may possibly reflect decreased risk perceptions in these participants, although the current design may not allow further conclusions about the direction of causation in these correlations. The understanding that sexual health behaviour might come about by an interplay between competing motives for behaviour could be used to optimise health-promotion strategies in the domain of sexual health. The motivational systems related to mating and pathogen-avoidance might antagonistically influence sexual behaviour, either *temporarily*, as

illustrated in research by Borg and De Jong (2012) or more *chronically*, as the observed association between trait pathogen-avoidance and sexual behaviour in the current studies seems to suggest (see also Duncan et al., 2009; Murray et al., 2013). Mating motives might ‘overrule’ the dispositional as well as the temporarily activated behavioural immune system, and hence might reduce *health concerns* associated with sexual behaviours. Conversely, as shown by our current results, high levels of pathogen-avoidance motives may reduce individuals’ interest in casual sex, and increase prophylactic behaviour.

How might up-regulation of pathogen-avoidance motivation – and thus increases in health-protective behaviour – be achieved by health promoters? One way health promotion research can benefit from knowledge of such evolved motives – including those relating to pathogen-avoidance – is to place emphasis on the *context* in which the health behaviour occurs, and to examine which contextual cues might trigger relevant motivational states that could bolster health-protective behaviour (e.g. Meertens et al., 2013). Although fear has often been a targeted emotion in health promotion research – with tentative effectiveness (Peters, Ruiter, & Kok, 2013), our current results suggest that the emotion disgust (as an important motivational state driving pathogen-avoidance) might be a more effective health promoting emotion.

Limitations and directions for future research

The study sample in the current research has a restricted age-range (18–27) with a large variance in sexual behaviour; it thus remains to be tested whether the observed relationships between the variables are similar in populations with other demographic characteristics. Moreover, the current cross-sectional design does not allow causal tests of the model we postulated, and thus further work is needed to test the model presented here. Given that our pathogen-avoidance measures reflect a temporal stable trait (Olatunji et al., 2012), we chose this variable as the most antecedent variable in our current models. In our view, both sociosexuality (casual sex history) and future health-protective behaviour can partly be understood by investigating pathogen-avoidance motivations. The validity of this model remains to be tested in follow-up research.

A further limitation of the current study is that the outcome variables currently used (intention to perform a behaviour) do not perfectly align with actual behaviour (see Webb & Sheeran, 2006). Conclusions that pathogen-avoidance processes influence *actual* health-protective behaviour are therefore tentative. Follow-up work is needed to bridge a possible intention-behaviour gap, and to examine the relationship between pathogen-avoidance motivation and actual health-protective behaviour. Future work could also address how the psychology of pathogen-avoidance relates to the participants’ behavioural beliefs about disease contraction.

Overall, our results show how pathogen-avoidance processes may provide a new angle for understanding health-protective behaviours, and might complement existing health psychology approaches in the prediction and changing of health behaviour. With an eye on health promotion, understanding when and how pathogen-avoidance motivation affects health-protective behaviour might contribute to the development of effective interventions. And, more generally, further exploration of fundamental motivational systems, like those pertaining to pathogen-avoidance, may provide novel and promising tactics to increase intervention effectiveness.

Disclosure statement

No potential conflict of interest was reported by the authors.

Supplemental data

Supplemental data for this article can be accessed here: <http://dx.doi.org/10.1080/08870446.2016.1161194>.

Notes

1. The data from Study 1 reported were collected as part of a larger study.
2. In order to ensure attentive reading of the questionnaire, an attention filter was added to the survey structure. This filter comprised three questions that did not deviate in content from the survey topic. Participants who read carefully were instructed to answer 'one' on the first question and 'six' on the second and third question. Instructional manipulation checks of this sort have become increasingly popular in research relying on crowdsourcing platforms. Indeed, the inclusion of such attention checks to the survey structure has been shown to increase the statistical power of subsequent hypotheses tests (Oppenheimer et al., 2009).
3. The PVD subscale-perceived infectability was also measured, but was not included in further analysis based on a preliminary analysis indicating a low correlation with the germ aversion facet, corresponding to previous analyses of this scale (see Tybur et al., 2014). Considering that the items of the germ aversion scale align more closely to pathogen-avoidance, this scale is often used as a proxy of pathogen-avoidance (e.g. Murray et al., 2013).

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