Selective effects of excessive engagement in health-related behaviours on disgust propensity

Bunmi O. Olatunji
Department of Psychology, Vanderbilt University, Nashville, TN, USA

The present study examined the extent to which engagement in health-related behaviours modulate disgust propensity, a purportedly stable personality trait. Participants were randomised into a health behaviour (n = 30) or control condition (n = 30). After a baseline period, participants in the health behaviour condition spent one week actively engaging in a clinically representative array of health-related behaviours on a daily basis, followed by a second week-long baseline period. Participants in the control condition monitored their normal use of health behaviours. Compared to control participants, those in the health behaviour condition reported significantly greater increases in disgust propensity after the health behaviour manipulation. This effect was most robust for contamination disgust propensity and remained significant when controlling for changes in health anxiety and disease fear. In contrast, self-disgust and anxiety sensitivity did not significantly differ between the two groups as a function of the health behaviour manipulation. Meditational analyses were consistent with the hypothesis that changes in the frequency of health-related behaviours, but not changes in health anxiety and disease fear, mediated the effects of the experimental manipulation on changes in contamination disgust propensity. These findings suggest that the purportedly stable personality trait of disgust propensity can be modulated by excessive engagement in health-related behaviours.

Keywords: Disgust propensity; Health behaviours; Safety behaviours.

It is widely accepted that the emotion of disgust evolved to serve a disease-avoidance function (Matchett & Davey, 1991; Oaten, Stevenson, & Case, 2009). Although this function may have been initially selective for facilitating avoidance of contaminated foods (Rozin & Fallon, 1987), disgust appears to be a mediator of a much broader adaptive system for disease avoidance (Curtis, Aunger, & Rabie, 2004). However, this system reacts with different levels of activation between individuals and over the lifetime of the same individual (Curtis, de Barra, & Aunger, 2011). Personality researchers have conceptualised variability in this level of activation to partially reflect individual differences in disgust proneness, a trait-like tendency to experience disgust frequently and intensely (Haidt, McCauley, & Rozin, 1994). Indeed, taxometric research has shown that disgust propensity is best
conceptualised as a dimensional construct that is present to a greater or lesser extent in all individuals (Olatunji & Broman-Fulks, 2007). Although much remains unknown about the development of disgust propensity, pathogen pressures may have led to the selection of disgust propensity in individuals that is universal and plastic to local environmental variation (Curtis et al., 2011). There is some evidence suggesting that individual differences in disgust propensity may have modest genetic influences (Kang, Kim, Namkoong, & An, 2010). However, research examining parent–child disgust associations have also reported generally stronger correlations (Davey, Forster, & Mayhew, 1993; Rozin, Fallon, & Mandell, 1984), suggesting that disgust propensity may be acquired via social transmission and modelling of pathogen concerns during childhood (Rozin, Haidt, & McCauley, 2008; Stevenson, Oaten, Case, Repacholi, & Wagland, 2010).

A growing body of research now suggests that individual differences in disgust propensity may confer risk for the development of anxiety-related disorders (Olatunji, Cisler, McKay, & Phillips, 2010). For example, measures of disgust propensity have been found to correlate significantly with measures of spider phobia (Woody, McLean, & Klassen, 2005), blood-injection-injury (BII) phobia (Olatunji, Sawchuk, de Jong, & Lohr, 2006) and symptoms of contamination-based obsessive-compulsive disorder (OCD; Olatunji, Sawchuk, Lohr, & de Jong, 2004) even after controlling for negative affect (Olatunji, Williams, Lohr et al., 2007). Thorpe, Patel, and Simonds (2003) also found that disgust propensity predicted symptoms of health anxiety/hypochondriasis. Extensions of this study have shown that the association between disgust propensity and health anxiety/hypochondriasis remains significant even after controlling for various indicators of negative affect (Davey & Bond, 2006; Fan & Olatunji, 2013; Olatunji, 2009). More recent research has also implicated disgust propensity in post-traumatic stress disorder (Engelhard, Olatunji, & de Jong, 2011; Olatunji, Armstrong, Fan, & Zhao, 2014). Given that the original adaptive function of disgust is to protect humans from risk of disease (Oaten et al., 2009), a disease-avoidance model has been the basis for understanding the association between disgust propensity and some anxiety-disorder symptoms (Davey, 2011). That is, disgust propensity may motivate avoidance of stimuli (spiders, blood and public rest rooms) that serve as disease vectors (Matchett & Davey, 1991). This disease-avoidance view may account for the association between disgust propensity and anxiety disorders such as spider phobia, BII phobia and contamination-based OCD given that the disorders involve avoidance of stimuli that are associated with disease contagion.

Despite its clear role in the development of anxiety-related disorders, very little research has examined factors that modulate disgust propensity. Like other personality traits (Costa & McRae, 1992), disgust propensity may reflect a stable pattern of behaviour, thought and emotion designed to monitor disease cues in the environment. In line with the view of disgust propensity as a personality trait, some studies have shown that disgust propensity remains relatively unchanged, even after successful treatment of specific phobias that are characterised by heightened disgust propensity (de Jong, Andrea, & Muris, 1997; Smits, Telch, & Randall, 2002). However, conceptualisations of personality also suggest that trait and state can coexist in the manifestation of a single psychological construct (Hertzog & Nesselroade, 1987; Roberts & DelVecchio, 2000). According to this view, the term state may be used to describe the individual’s expression of a particular characteristic at a particular point in time (Cole, Martin, & Steiger, 2005); as such, one’s state is the result of both time-invariant influences (called traits) and time-varying influences (called occasions). The question then remains as to the time-varying occasions that influence disgust propensity. According to Reynolds, Conedine, Pizarro, and Bissett (2012), disgust propensity is a dynamic system that is able to adapt according to variations in an individual’s vulnerability. This view suggests that when vulnerability to pathogens increases, so too does disgust propensity. This view is in line with recent research showing that the effect of experienced disgust on delay and avoidance in sexual healthcare decision-making was stronger among those with poorer...
subjective health (McCambridge & Consedine, 2014). This view is also in line with research that has observed heightened disgust propensity in the first trimester, where maternal and foetal vulnerability to disease is high, relative to later stages of pregnancy (Fessler, Eng, & Navarrete, 2005).

Although there is some evidence suggesting that actual disease threat is one occasion that may influence disgust propensity (Fessler et al., 2005), it remains unclear if perceived disease threat may have a similar effect. Health behaviours that may take the form of actions designed to detect a perceived impending threat in the environment may very well have an influence on disgust propensity given that they also serve the function of disgust avoidance. Health behaviours in this context may serve the function of “safety behaviors” (Helbig-Lang & Petermann, 2010). Some health behaviours that may serve the function of safety behaviours employed to cope with perceived disease threat include excessive hand washing, seeking reassurance from external sources (e.g., doctors, Internet, books), body checking (e.g., taking blood pressure, feeling for lumps) and avoidance of cues associated with disease (e.g., hospitals, cancer floors, Abramowitz, 2008). Although the use of health behaviours in the presence of actual threat is essential for survival, excessive and inflexible use of such behaviours may result in significant distress (e.g., Salkovskis, 1991). Health behaviours are ubiquitous, often adaptive and inherently non-pathological and logical responses to the perception of disease threat (Gangemi, Mancini, & van den Hout, 2012). Although they are necessary for survival, anxious individuals often employ them in the absence of objective danger.

The excessive use of health behaviours might also contribute to the development and exacerbation of anxiety symptoms. In one examination of this notion (Deacon & Maack, 2008), participants with either low or high levels of contamination fear underwent a week-long baseline period after which they spent one week engaging in a clinically representative array of contamination-related safety behaviours on a daily basis, followed by a second baseline period. Subsequent to the safety behaviour manipulation, participants evidenced statistically significant increases in threat overestimation, contamination fear symptoms and behavioural avoidance of contaminants. Similarly, health-related behaviours may be employed to reduce the perception of disease threat, consequently producing a short-term reduction in distress (Abramowitz & Moore, 2007). However, research has shown that such safety behaviours are negatively reinforcing in that they maintain distress in the long-term (Salkovskis, Thorpe, Wahl, Wroe, & Forrester, 2003).

Prior research has shown that participants who had heightened contamination sensitivity and were more disgust sensitive had significantly fewer recent infections (Stevenson, Case, & Oaten, 2009), perhaps because they engage in more frequent hygienic behaviour, especially hand washing. However, the extent to which engagement in such health-related behaviours represents an occasion that exacerbates disgust propensity, a purportedly stable personality trait, is unknown. Excessive engagement in health-related behaviours may increase disgust propensity by making disease risk more salient. Individuals show variation in disgust propensity and plasticity in disgust propensity may also reflect the degree of variability in real and perceived disease risk (Curtis et al., 2011). Excessive engagement in health-related behaviours may function to increase the perception of pathogen exposure. Consistent with this view, prior research has shown that engagement in contamination-related safety behaviours results in heightened awareness of contaminants in the environment (Deacon & Maack, 2008). When disease risk is made more salient by engagement in health behaviours, disgust propensity may increase as an adaptation designed to facilitate avoidance of disease vectors.

Examination of the potential effects of engagement in health-related behaviours on disgust propensity does require some consideration of the dimensionality of the construct. Theoretical formulations (Rozin et al., 2008) and empirical research (Olutunji, Williams, Tolin et al., 2007) suggest that the major domains consist of core, animal-reminder and contamination disgust. Core disgust is characterised primarily as a food-rejection
response centred on oral incorporation of offensive stimuli (i.e., eating monkey meat). Animal-reminder disgust includes items about death and body-envelope violations that may be related to a sense aversion because they are reminders of human animality and mortality (i.e., touching a dead body). Lastly, a key component of interpersonal disgust is disease probability and this aspect is largely captured by contamination disgust (i.e., accidentally drinking from someone else’s cup). Research has shown that core, animal-reminder and contamination disgust have unique personality, behavioural, physiological and clinical correlates (Olatunji, Haidt, McKay, & David, 2008). For example, Fan and Olatunji (2013) found that contamination disgust propensity was a stronger predictor of avoidance of potential health hazards than core or animal-reminder disgust propensity. Furthermore, research has also shown that the three domains may be influenced by different genetic markers (Kang et al., 2010). Given the distinctive properties of the domains of disgust, it may be expected that engagement in health-related behaviours may be a stronger modulator of contamination disgust relative to the other domains of disgust.

The present study employs a reanalysis of published data (Olatunji, Etzel, Tomarken, Ciecielski, & Deacon, 2011) to examine the extent to which excessive engagement in health-related behaviours influences disgust propensity.1 In this study, participants engaged in a large number of health-related behaviours each day for one week. Week-long baseline periods during which participants behaved as they typically do occurred immediately before and after the health behaviour manipulation. It was predicted that compared to a control condition, participants in the health behaviour manipulation would evidence significantly greater disgust propensity. This effect was predicted to be strongest for the contamination disgust domain relative to core and animal-reminder disgust. It was also hypothesised that responses to the health behaviour manipulation would be specific to disgust propensity that is marked by concerns of contact with environmental pathogens rather than disgust towards the self or sensitivity to mood states in general. Building on these hypotheses, the present study also examined whether changes in the frequency of health-related behaviours mediate the effects of the health behaviour manipulation on changes in disgust propensity. How sample size was determined, all data exclusions (if any), all manipulations and all measures for the present investigation are reported later.

**METHOD**

**Participants**

Sixty undergraduate participants at a southern university were randomly assigned to either a control (n = 30; 73.3% female) or health behaviour (n = 30; 80.0% female) group. This sample size was determined based on findings from a similar study (Deacon & Maack, 2008) that employed a similar number of participants. This previous study yielded a large effect size for the contrast of safety behaviours during the safety behaviour phase compared to the baseline phase (d = 3.32).

---

1 The original study examined the extent to which safety behaviours exacerbate symptoms of hypochondriasis (severe health anxiety). The findings showed that compared to control participants, those in the safety behaviour condition reported significantly greater increases in health anxiety, hypochondriacal beliefs, contamination fear and behavioural avoidance of health risks after the safety behaviour manipulation. In contrast, general anxiety symptoms did not significantly differ between the two groups as a function of the manipulation. Mediation analyses were also conducted and were consistent with the hypothesis that changes in the frequency of health-related thoughts mediated the effects of the experimental manipulation on health anxiety. This reanalysis of the published data is unique in addressing how engagement in safety behaviours influence disgust propensity, a personality trait that is described as stable in the existing literature. To our knowledge, this research question has not been addressed in the literature. This reanalysis also offers an incremental contribution by examining which component (core, animal-reminder contamination) of disgust propensity is most influenced by excessive engagement in health-related behaviours. These are substantive research questions that were not addressed in the original publication that this reanalysis is well positioned to address.
The mean age of the total sample in the present study was 19.33 years. Gender, age and ethnicity did not differ significantly between the two groups.

**Experimental design**

This study utilised a simple between-subjects phase change A/B/A design (Hayes, Barlow, & Nelson-Gray, 1999). For those in the health behaviour condition, the three-week study period consisted of the following week-long phases (described in further detail later): (1) baseline phase during which participants monitored their normal frequency of health behaviours; (2) health behaviour phase during which participants were instructed to engage in (and monitor) a high frequency of health behaviours each day; and (3) return to baseline phase during which participants once again were instructed to engage in (and monitor) their normal frequency of health-related behaviours. Those in the control condition monitored their normal use of health-related behaviours at each phase. Assessments were conducted before and after each phase, yielding a total of four assessment time points.

**Measures**

The *health behaviour checklist* (HBC; Olatunji et al., 2011). Respondents were asked to note whether or not they performed each of 34 health-related behaviours that day by indicating either “Yes” or “No”. A third option, “N/A”, was provided in case participants did not have the opportunity to perform a particular behaviour that day. Table 1 presents each health-related behaviour on the checklist. A wide array of items was included on the checklist to adequately capture health concerns broadly and to increase the likelihood of compliance with engagement in the usage of the behaviours. Participants completed a HBC at the end of each day during the three-week study period. Total scores were derived by calculating the weekly sum of “Yes” responses on the checklist across each of the seven days of a given study phase (baseline, health behaviour, return to baseline).

The *disgust scale-revised* (DS-R; Haidt et al., 1994; modified by Olatunji, Williams, Tolin, et al., 2007) is a 25-item measure of disgust propensity corresponding to the three factors of core (i.e., foods, small animals, body products), animal-reminder (i.e., death, body-envelope violations) and contamination (i.e., interpersonal) disgust. The items are rated on a 5-point Likert-type scale from 0 (“strongly disagree” or “very untrue about me”) to 4 (“strongly agree” or “very true about me”). The internal consistency of the DS-R (baseline $\alpha = .86$, week 1 $\alpha = .87$, week 2 $\alpha = .86$, week 3 $\alpha = .89$) in the present study was good.

The *Whiteley index* (WI; Pilowsky, 1967) is a 14-item measure of hypochondriacal beliefs. Items assess disease fear, disease conviction and bodily preoccupation that make up the symptom cluster of clinical hypochondriasis. The items are rated on a 5-point Likert-type scale from 0 (“not at all”) to 4 (“a great deal”). The internal consistency of the WI (baseline $\alpha = .74$, week 1 $\alpha = .77$, week 2 $\alpha = .80$, week 3 $\alpha = .81$) in the present study was adequate.

The *self-disgust scale* (SDS; Overton, Markland, Taggaert, Bagshaw, & Simpson, 2008) is an 18-item measure designed to assess disgust experienced towards the self. The scale includes six neutral statements and additional items corresponding to two self-disgust constructs: *Disgusting Self* and *Disgusting Ways*. Subjects rate their agreement with each item on a scale ranging from 1 ("totally agree") to 7 ("disagree very much"). The internal consistency of the SDS (baseline $\alpha = .87$, week 1 $\alpha = .87$, week 2 $\alpha = .82$, week 3 $\alpha = .82$) in the present study was good.

---

2 Here data are presented on changes on measures of disgust propensity, self-disgust and anxiety sensitivity. However, measures of health anxiety, contamination fear, negative affect and behavioural avoidance were also administered as part of the original study but were not included in these analyses given that they were presented in the original study that addressed a separate theoretical question.
The anxiety sensitivity index-3 (ASI-3; Taylor et al., 2007) is an 18-item measure of fear of anxious arousal on a 0 (very little) to 4 (very much) scale. The questionnaire measures fear of arousal across domains of physical concerns (e.g., “It scares me when my heart beats rapidly”), cognitive concerns (e.g., “When my thoughts seem to speed up, I worry that I might be going crazy”) and social concerns (e.g., “It scares me when I blush in front of other people”). The internal consistency of the ASI-3 (baseline $\alpha = .88$, week 1 $\alpha = .87$, week 2 $\alpha = .87$, week 3 $\alpha = .89$) in the present study was good.

### Procedure

During the first laboratory meeting (Baseline) and following the informed consent process, participants completed the DS-R, WI, SDS and ASI-3. This assessment was repeated during the second, third and fourth laboratory meetings. Lastly, participants were asked to complete the HBC each day during the three-week study period. For the first week of the study, participants were instructed that we were interested in normal day to day behaviours and not to change their routine behaviour in any way.
During the second laboratory visit (week 1), participants were randomly assigned to either a health behaviour or a control condition following the assessment. Those in the health behaviour condition were told that we were assessing if people can engage in more of these behaviours than they normally do, and were instructed to engage in each behaviour identified in Table 1 at every possible opportunity on a daily basis for the upcoming week. To increase compliance, participants in both groups received daily email reminders to complete the HBC each night. To facilitate this task, participants were given two trial-size bottles of Germ-X hand sanitiser to be carried with them at all times, a container of Clorox surface disinfectant wipes and seven tongue depressors to check their throats for inflammation each day of the week. Participants were instructed to use the anti-bacterial Clorox wipes to disinfect certain objects at home (i.e., telephone receivers, toilet seats and handles, bathroom door-knobs and faucets, kitchen countertops) that might be particularly likely to harbour germs. Participants were also encouraged to avoid touching anything they thought might be contaminated by germs and to disinfect their hands immediately when contact was unavoidable. Those in the control condition were instructed to continue monitoring their normal routine behaviours. During the third assessment (week 2), participants were encouraged to spend the following week returning to their normal, baseline frequency of health-related behaviours. As the fourth assessment (week 3) took place following the final week of the study, no further instructions regarding health-related behaviours were provided. Participants were then debriefed with information regarding the research hypotheses.

RESULTS

Manipulation check

To confirm that participants in the health behaviour condition complied with instructions to increase their performance of health-related behaviours during the manipulation week, the average number of self-reported health behaviours per week reported on the HBC during the three study phases was examined (see Table 2).

Table 2. Means and standard deviations of health behaviours and disgust propensity, health anxiety/disease fear, self-disgust and anxiety sensitivity across the assessment weeks for each condition

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Health</td>
<td>Control</td>
<td>Health</td>
</tr>
<tr>
<td>DS-R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>61.3</td>
<td>60.67</td>
<td>59.47</td>
<td>59.27</td>
</tr>
<tr>
<td>SD</td>
<td>15.70</td>
<td>15.06</td>
<td>15.37</td>
<td>14.59</td>
</tr>
<tr>
<td>WI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>3.50</td>
<td>4.13</td>
<td>3.20</td>
<td>3.60</td>
</tr>
<tr>
<td>SD</td>
<td>2.47</td>
<td>3.03</td>
<td>2.99</td>
<td>2.67</td>
</tr>
<tr>
<td>SDS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>26.70</td>
<td>28.50</td>
<td>25.80</td>
<td>28.13</td>
</tr>
<tr>
<td>SD</td>
<td>8.77</td>
<td>8.72</td>
<td>9.40</td>
<td>8.64</td>
</tr>
<tr>
<td>ASI-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>15.46</td>
<td>16.73</td>
<td>14.53</td>
<td>16.13</td>
</tr>
<tr>
<td>SD</td>
<td>9.46</td>
<td>11.91</td>
<td>8.83</td>
<td>11.26</td>
</tr>
<tr>
<td>HBC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>–</td>
<td></td>
<td>4.13</td>
<td>5.03</td>
</tr>
<tr>
<td>SD</td>
<td>–</td>
<td></td>
<td>2.50</td>
<td>2.18</td>
</tr>
</tbody>
</table>

DS-R, disgust scale-revised; WI, Whiteley index; SDS, self-disgust scale; ASI-3, anxiety sensitivity index-3; HBC, health behaviour checklist.
for means and standard deviations). A 2 (group: health behaviour, control) × 3 (time: weeks 1, 2 and 3) analysis of variance (ANOVA) on the HBC revealed a significant main effect of group \(F(1, 52) = 73.60, p < .001, \eta^2 = .59\) and time \(F(2, 104) = 100.99, p < .001, \eta^2 = .66\) that was qualified by a significant group × time interaction \(F(2, 104) = 106.96, p < .001, \eta^2 = .67\). Tests of simple effects examining this interaction revealed that the main effect of time was not statistically significant in the control group \(F(2, 52) = 3.09, p > .05, \eta^2 = .15\), suggesting that HBC scores remain unchanged in this group. However, the main effect of time in the health behaviour group was significant \(F(2, 52) = 113.07, p < .001, \eta^2 = .81\). Pairwise comparisons for the health-related behaviour group revealed that scores on the HBC were higher \((ps < .001)\) during the health behaviour phase, during which participants were instructed to engage in a high frequency of health-related behaviours (week 2) compared to the week 1 baseline and the week 3 return to baseline phase. Scores on the HBC were also higher \((p < .001)\) for the health behaviour group during the week 3 return to baseline phase compared to the week 1 baseline phase. The group × time interaction was also probed by examining group differences at each time point. As predicted, the two groups did not differ in HBC scores after the week 1 baseline \((p = .161; \eta^2 = .03)\). However, those in the health behaviour group engaged in a high frequency of health-related behaviours after week 2 \((p < .001; \eta^2 = .77)\) and week 3 \((p < .001; \eta^2 = .30)\) compared to the control condition.

**Effects of health-related behaviours on disgust propensity**

A 2 (group: health behaviour, control) × 3 (time: baseline, weeks 1, 2 and 3) ANOVA was conducted on the DS-R to examine changes in disgust propensity as a function of the health-related behaviour manipulation (see Table 2 for means and standard deviations). The results revealed a significant main effect of time \(F(3, 174) = 6.32, p < .01, \eta^2 = .10\). Although a significant main effect of group \(F(1, 58) = 0.14, p > .05, \eta^2 = .002\) was not observed, the predicted group × time interaction \(F(3, 174) = 3.71, p < .02, \eta^2 = .06\) was statistically significant. Tests of simple effects examining this interaction revealed that the main effect of time was not statistically significant in the control group \(F(3, 87) = 1.99, p > .05, \eta^2 = .06\), suggesting that disgust propensity was unchanged in the control group. In contrast, the main effect of time in the health behaviour group was significant \(F(3, 87) = 8.55, p < .001, \eta^2 = .23\). Pairwise comparisons for the health behaviour group revealed that disgust propensity was higher \((p < .01)\) during the health behaviour phase when participants were engaging in a high frequency of health-related behaviours (week 2) compared to the initial baseline and the week 1 baseline phase. This effect was also maintained at the week 3 return to baseline phase given that disgust propensity levels at weeks 2 and 3 did not significantly differ \((p = .91)\).

**Distinctions from health anxiety and disease fear**

A 2 (group) × 3 (time) analysis of covariance (ANCOVA) was conducted on the DS-R with changes in WI scores as a function of the health behaviour manipulation (week 2 WI − week 1 WI) as a covariate. The results revealed a significant main effect of time \(F(3, 171) = 5.96, p < .01, \eta^2 = .09\). Although a significant main effect of group \(F(1, 57) = 0.20, p > .05, \eta^2 = .004\) was not observed, the predicted group × time interaction \(F(3, 171) = 2.56, p = .056, \eta^2 = .04\) was marginally significant. Tests of simple effects examining this interaction revealed that the main effect of time was not statistically significant in the control group \(F(3, 84) = 2.23, p > .05, \eta^2 = .07\) when controlling for changes in WI scores. In contrast, the main effect of time in the health behaviour group remained significant \(F(3, 84) = 7.62, p < .001, \eta^2 = .21\) when controlling for changes in WI scores. This suggests that the finding of higher
disgust propensity when participants were engaging in a high frequency of health-related behaviours is not fully accounted for by changes in health anxiety and disease fear as assessed by the WI.

Specificity of disgust domains

A 2 (group) × 3 (time) × 3 (disgust domain: core, animal-reminder, contamination) ANCOVA was conducted on the three disgust subscales of the DS-R (see Table 3 for means and standard deviations) with changes in WI scores (week 2 WI − week 1 WI) as a covariate. The results revealed a significant main effect of time \( F(3, 171) = 6.19, \ p < .01, \) partial \( \eta^2 = .09 \) and disgust domain \( F(2, 114) = 64.49, \ p < .001, \) partial \( \eta^2 = .53 \). These main effects were qualified by a significant group × time interaction \( F(3, 171) = 3.26, \ p < .03, \) partial \( \eta^2 = .05 \), as well as a significant group × time × disgust domain interaction \( F(6, 342) = 2.24, \ p < .04, \) partial \( \eta^2 = .04 \). To further probe this three-way interaction, separate group × time ANCOVAs were conducted for each of the three DS-R subscales with changes in WI scores as a covariate. Examination of core disgust revealed only a marginally significant main effect of time \( F(3, 171) = 2.61, \ p = .053, \) partial \( \eta^2 = .04 \). Similarly, examination of animal-reminder disgust revealed only a significant main effect of time \( F(3, 171) = 5.46, \ p < .01, \) partial \( \eta^2 = .08 \). However, examination of contamination disgust revealed a significant main effect of time \( F(3, 171) = 3.20, \ p < .03, \) partial \( \eta^2 = .05 \) that was further qualified by a significant group × time interaction \( F(3, 171) = 4.92, \ p < .01, \) partial \( \eta^2 = .08 \). Subsequent examination of the interaction revealed that the main effect of time was not statistically significant in the control group \( F(3, 84) = 1.32, \ p > .05, \) partial \( \eta^2 = .04 \) when controlling for changes in WI scores but was significant in the health behaviour group \( F(3, 84) = 7.14, \ p < .001, \) partial \( \eta^2 = .20 \). As depicted in Figure 1, pairwise comparisons for the health behaviour

![Figure 1. Change in contamination disgust propensity over time.](image-url)
group revealed that contamination disgust was higher ($p < .001$) during health behaviour phase when participants were engaging in a high frequency of health behaviours (week 2) compared to the initial baseline and the week 1 baseline phase. This effect was also maintained at the week 3 return to baseline phase given that contamination disgust levels at weeks 2 and 3 did not significantly differ ($p = .78$).

**Effects of health-related behaviours on self-disgust**

A 2 (group: health behaviour, control) × 3 (time: baseline, weeks 1, 2 and 3) ANCOVA was conducted on the SDS to examine changes in self-disgust as a function of the health behaviour manipulation (see Table 2 for means and standard deviations). The results revealed a significant main effect of time [$F (3, 174) = 5.02, p < .01$, partial $\eta^2 = .08$]. However, the main effect of group [$F (1, 58) = 0.56, p > .05$, partial $\eta^2 = .01$] and the group × time interaction [$F (3, 174) = 1.85, p > .05$, partial $\eta^2 = .03$] were not statistically significant.

**Effects of health-related behaviours on anxiety sensitivity**

A 2 (group: health behaviour, control) × 3 (time: baseline, weeks 1, 2 and 3) ANOVA was conducted on the ASI-3 to examine changes in anxiety sensitivity as a function of the health behaviour manipulation (see Table 2 for means and standard deviations). The results revealed no statistically significant main effect of time [$F (3, 174) = 0.52, p > .05$, partial $\eta^2 = .01$], group [$F (1, 58) = 1.10, p > .05$, partial $\eta^2 = .02$], or group × time interaction [$F (3, 174) = 1.79, p > .05$, partial $\eta^2 = .04$].

**Delineating mediators of changes in disgust propensity**

The extent to which changes in the frequency of health-related behaviours (week 2 HBC – week 1 HBC) and changes in health anxiety and disease fear (week 2 WI – week 1 WI) mediated the effects of the experimental manipulation on changes in contamination disgust propensity (week 2 DS-R contamination subscale – week 1 DS-R contamination subscale) was then examined (see Figure 2). A test of mediation was conducted with Preacher and Hayes (2008) bootstrapping procedure, which does not impose distributional assumptions often violated in smaller samples. Bootstrapping is a non-parametric method that generates an estimate of the indirect effect, including a 95% confidence interval. When zero is not in the 95% confidence interval, one can conclude that the indirect effect is significantly different from zero at $p < .05$ (two-tailed); thus, the effect of the independent variable (experimental condition) on the dependent variable (changes in contamination disgust) is mediated by the proposed mediating variable (changes in the frequency of health-related behaviours, changes in health anxiety and disease fear). The mediational analysis revealed that the true indirect effects for changes in the frequency of health-related behaviours and changes in health anxiety and disease fear were estimated to lie between 0.6938 and 3.7729, and -0.1805 and 0.3902, respectively (total $z = 2.72, p < .007$). Because zero was not in the 95% confidence interval for changes in the frequency of health-related behaviours only, it can be concluded that the indirect effect is significantly different from zero at $p < .01$, and that changes in the frequency of health-related behaviours ($z = 2.65, p < .008$) mediate the relationship between the experimental condition and changes in contamination disgust, whereas changes in health anxiety and disease fear ($z = .15, p = .87$) do not.

**DISCUSSION**

The present study investigated the extent to which excessive engagement in health-related behaviours that have been shown to potentiate inaccurate disease threat beliefs (Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999) exacerbate disgust propensity levels. Consistent with predictions, participants who actively engaged in a representative array of health-related behaviours demonstrated a significant increase in disgust propensity compared to
the control group. Engagement in health-related behaviors may be expected to also increase anxiety about one's health (Olatunji et al., 2011). However, these findings remained largely unchanged when controlling for changes in health anxiety and disease fear. Although disgust propensity is a personality trait that is relatively stable over time (Haidt et al., 1994), these present findings suggest that excessive engagement in health-related behaviors may exacerbate, albeit modestly, disgust propensity. Engagement in health-related behaviors may have these effects by making disease risk more salient (Deacon & Maack, 2008). Although the present findings suggest that engaging in health behaviors increases disgust propensity, making disease risk more salient alone may be necessary and sufficient for increasing disgust propensity to some degree. From a learning standpoint, however, engagement in the actual health behaviors may more strongly reinforce maladaptive beliefs about disease risk, which may then yield more robust changes in disgust propensity relative to making disease risk more salient alone.

Although the present study suggests that periods of excessive engagement in health-related behaviors represent a time-varying occasion that influences trait disgust propensity, the question remains as to the practical implications of such an effect. Consider that the spread of the H1N1 strain of the influenza virus, commonly referred to as the "swine flu", was detected in April 2009, and by June of that year the World Health Organization declared it a global pandemic (Chan, 2009). In the USA, the following fall and winter months (which comprise flu season) saw a flood of media reports on the swine flu. One benefit of the media reports is that they facilitated rapid communication of the risks of infection. Such communication may have promoted engagement in health-related behaviors that reduced the spread of contagion.

Figure 2. Mediation model of the relations between experimental group, change in frequency of health-related behaviours and change in contamination disgust propensity. Path c in the model refers to the total effect and path c’ refers to the direct effect. ± = p < .08, *= p < .05.
(Sandman, 2009). However, Rubin, Amlot, Page, and Wessely (2009) reported that approximately 24% of individuals screened in the early stages of the H1N1 influenza outbreak reported significant anxiety in response to the outbreak. Furthermore, increased anxiety was found to be positively associated with the likelihood of engaging in health-related behaviours such as hand washing and disinfecting doorknobs (which was recommended). Increased anxiety also predicted engagement in health behaviours such as taking time off from work and avoiding public transportation and crowds (which was not recommended). Although excessive engagement in health-related behaviours during a period of pandemic illness may prevent infection (Stevenson et al., 2009), a potential consequence may be an increase in disgust propensity that leads to excessive use of health behaviours that is not warranted.

Recent research has shown that disgust propensity uniquely predicts swine flu-related anxiety (Wheaton, Abramowitz, Berman, Fabricant, & Olatunji, 2012). This suggests that those with a lower threshold for experiencing disgust tend to experience more anxiety about health. One way such individuals may cope with the perceived threat to their health during periods of pandemic illness is engagement in health behaviours (Olatunji et al., 2011). However, the present study did find that participants in the health behaviour condition continued to report significantly higher levels of disgust propensity after the final baseline week where participants in both groups were instructed to monitor only their normal health behaviour use. This finding is consistent with previous research suggesting that learned disgust responses may be especially difficult to unlearn (Mason & Richardson, 2010; Olatunji, Forsyth, & Cherian, 2007). One interpretation of the finding is that the increase in disgust propensity during the health behaviour phase maintained elevated use of health-related behaviours during the return to baseline phase, which then resulted in the maintenance of elevated disgust propensity levels. Another interpretation is that once trait disgust propensity has been increased by engagement in health-related behaviours, this specific time-varying influence may also result in a relatively permanent shift in the disease-avoidance system.

There is consistent evidence that disgust propensity, as assessed by the DS-R, is not a unitary construct (Olatunji, Williams, Tolin, et al., 2007). The major domains of disgust assessed by the DS-R include core, animal-reminder and contamination disgust and research has shown that the three disgust domains have distinct correlates (Olatunji et al., 2008). The present study found that participants who engaged in health-related behaviours reported significantly greater increases in contamination disgust propensity specifically, the causal mechanism remains unclear. The present study did find that changes in the frequency of health-related behaviours, but not changes in health anxiety and disease fear, mediated the differences between the health behaviour and control conditions in changes in contamination disgust propensity. Although changes in catastrophic thoughts about the perceived likelihood and severity of acquiring a disease may be an additional causal mechanism, these mediational findings suggest that simply increasing the frequency of health-related behaviours is sufficient to trigger significant increases in contamination disgust propensity. However, disgust propensity and health-related behaviours may have a reciprocal relationship in which they interact in a synergistic, bidirectional manner. In this relationship, engagement in health-related behaviours influences disgust propensity and vice versa.

A reciprocal model suggests that during occasions where disgust propensity increases, use of health-related behaviours may also increase. A theoretical model which draws from the existing literature may be formulated that describes the nature of the reciprocal relationship between health-related behaviours and disgust propensity. Similar to models of the development of contamination propensity (Deacon & Maack, 2008), health-related behaviours increase selective attention towards potential health hazards in the environment. Indeed, active efforts to
neutralise health hazards require one to notice such hazards. As such, the health behaviour phase in the present study may be viewed as a manipulation of both overt behaviour and the attentional allocation necessary for the application of such behaviour. Given that contact with health hazards can be difficult to avoid, increased attention towards such hazards should increase their perception. This increased perception, in turn, might have led participants to view themselves as at increased risk for disease contagion. Accordingly, the health behaviour manipulation led to significant increases in disgust propensity—a proposed vulnerability factor in several anxiety disorders (Olatunji et al., 2011). Although such a model would also implicate a reciprocal relationship where disgust propensity then influences health behaviour use, future research involving the independent assessment of these constructs at multiple time points is needed to more directly test for these potential causal and reciprocal effects.

Empirical evidence from the existing literature supports a theoretical model where changes in attention, perception and interpretation may represent core cognitive mechanisms that may account for the effects of excessive engagement in health behaviours on changes in disgust propensity. Indeed, research has shown that health behaviours prevent proper fear extinction and this effect may be accounted for by high-level cognitive processes such as attention and reasoning (Lovibond, Mitchell, Minard, Brady, & Menzies, 2009). Consistent with this view, previous research has shown that engagement in safety behaviours results in an increase in threat appraisal which then leads to an increase in distress (Gaynor, Ward, Garety, & Peters, 2013). Previous research has also shown that engagement in safety behaviours results in the maintenance of negative judgments about anxiety (Taylor & Alden, 2010). Similarly, excessive engagement in health-related behaviours may also be motivationally salient for increasing disgust propensity because such behaviours convey information potentially affecting survival. Prior research has shown that anxious patients tend to engage in emotional reasoning such that they draw invalid conclusions about a situation on the basis of their subjective emotional response (Arntz, Raufer, & van den Hout, 1995). More recent research by Gangemi et al. (2012) suggests that the same is also true for conclusions drawn based on health behaviours that function as safety behaviours (“If I avoid/wash hands etc., then there must be a danger of contamination”). Once health-related danger is inferred by engaging in health behaviours, specific processes that motivate avoidance of potential disease-causing agents may be more readily accessed. This may partially account for the stronger increase in disgust propensity relative to other traits.

Further delineation of the reciprocal relationship between health behaviour use and disgust propensity may contribute to a better understanding of the development and maintenance of some anxiety disorders (Olatunji et al., 2011). Indeed, prior research has shown that excessive engagement in contamination-related safety behaviour increases symptoms of OCD (Deacon & Maack, 2008). Given prior research implicating disgust propensity in contamination-related OCD (Olatunji et al., 2004), excessive engagement in health behaviours may be a mechanism by which disgust propensity confers risk for the development of OCD. In fact, it is likely that the observed increase in disgust propensity observed in the present study may reflect increases in contamination obsessions and washing compulsions to some degree. There are two reasons why this may be the case. First, some of the health behaviours used in the present study also reflect contamination concerns (e.g., cleaning and disinfecting surfaces in your home with antibacterial wipes). Second, examination of specific propensity domains revealed changes in contamination disgust, but not core or animal-reminder disgust, as a function of the health behaviour manipulation. The possibility that the increase in disgust propensity as a function of the health behaviour manipulation partially reflects increases in contamination obsessions and washing compulsions may not be surprising given that prior research has revealed significant associations between health anxiety and contamination obsessions and washing compulsions (Olatunji, 2009). This suggests that there is likely some overlap in the mechanisms.
(i.e., disease avoidance) that contribute to the two clinical symptoms.

These findings may also have important treatment implications. Although the present study did find that participants in the health behaviour condition continued to report higher levels of disgust propensity even when instructed to monitor only their normal use of health behaviours, elimination of health behaviours that function as safety behaviours during treatment of some anxiety disorders may more robustly reduce disgust propensity which may then help to maximise treatment outcome (Olatunji, Tart, Ciesielski, McGrath, & Smits, 2011). By systematically eliminating safety behaviours during treatment, anxiety patients may increasingly be better able to disconfirm the disease threat beliefs that maintain heightened levels of disgust propensity. It is important to note that future research on at risk and clinical samples will be needed before stronger inferences can be made about the treatment implications of these findings. Indeed, the health behaviour manipulation was associated with approximately a four point change (on average) on the DS-R. Although this was a statically significant effect, it may be limited in terms of clinical significance. Replication of this study with more intense and frequent health behaviours with at risk and clinical samples may yield robust effects that are more clinically meaningful.

The present findings also suggest that engagement in health-related behaviours more strongly modulate disgust propensity relative to other traits. Although changes in self-disgust and anxiety propensity appeared to show a similar pattern, the observed changes as a function of the health behaviour manipulation were not statistically significant. This is the first study to our knowledge to identify an occasion that increases disgust propensity. Although this finding was observed while employing an ecologically valid health behaviour manipulation and an experimental design that maximised internal validity by ruling out confounds associated with a traditional A/B designs such as the passage of time, reactivity to repeated assessment and regression to the mean (Hayes et al., 1999), the present study is not without limitations. Given that the health behaviour manipulation occurred outside of the laboratory, there is admittedly no objective way of knowing to what extent the health behaviour group actually engaged in the health behaviours. Furthermore, the use of an undergraduate analogue sample limits the extent to which the present findings generalise to a clinical sample. Another limitation is that the influence of demand characteristics cannot be completely ruled out. That is, it is possible that participants realised the study hypotheses and complied by reporting higher levels of disgust propensity following the health behaviour manipulation. However, it is important to note that disgust propensity did not increase during the two week-long periods of daily monitoring of health behaviours, and that the effects of the manipulation were strongest for disgust propensity.

Perhaps what is innovative about this study is that change in use of health behaviours alone seems to be sufficient to modulate disgust propensity. Although change in behaviour may be a sufficient mechanism for understanding these effects, behavioural change does not occur in isolation and it is likely that there are many theoretically plausible intervening cognitive and/or motivational mechanisms at play. Unfortunately, such mechanisms were not assessed in the present study. Future research that directly assesses some of the implicated cognitive and/or motivational mechanisms may result in a more nuanced understanding of how excessive engagement in health behaviours modulates disgust propensity. It is important to note that such a relationship may not consistently replicate across cultures. Indeed, Barra, Islam, and Curtis (2014) recently found that adults in rural Bangladesh with more infectious diseases in childhood did not show greater adult disgust propensity. This null finding suggests that in some cultures other processes such as the degree to which disease risks are avoidable or perceived to be avoidable may be necessary in order for the association between health-related behaviours and disgust propensity to be observed. Another important consideration is that the present study focused only on disgust propensity. Disgust sensitivity reflects individual differences in the appraisal of the experience of
disgust (the tendency to find the emotion of disgust unpleasant) and future research may benefit from examining the extent to which excessive engagement in health-related behaviours also influences this trait. Given that the findings reported in the present study are limited by reliance on self-report measures, a more nuanced understanding of how excessive engagement in health behaviours modulates disgust propensity will require assessment of other response modalities. Despite the study limitations, the present study highlights an important context where disgust propensity, a purportedly stable personality trait, can be modulated. Future research addressing the study limitations may further elucidate distinct processes that contribute to the malleability of trait disgust propensity.

REFERENCES


