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Modern Health Worries and Emotional Reactivity to Images of Air Pollution

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Abstract

Modern health worries (MHW) represent individual differences in the perceived threat posed to health and well-being by aspects of modern life. Current evidence suggests that MHW are positively associated with trait negative emotionality, and given that trait negative emotionality is associated with state emotional reactivity to environmental stressors, it is reasonable to expect that persons with elevated MHW would show increased state emotional reactivity to MHW-related stimuli. Consequently, this study aimed to investigate the association of MHW with state emotional reactivity (i.e., valence and arousal) to MHW-related stimuli (i.e., images of air pollution). Combining these stimuli with other stimuli varying in valence and arousal allowed us to examine whether MHW are specifically associated with emotional reactivity induced by MHW-related stimuli. A total of 73 college students viewed 48 images encompassing eight different content areas, including a subset of MHW-related images (air pollution); each image was rated for valence and arousal. Participants also completed measures of MHW, trait negative emotionality (i.e., neuroticism), and demographics. After controlling for neuroticism and gender, results suggest that MHW only predicted valence rating for images of air pollution; conversely, MHW appears to be associated with arousal ratings in response to a variety of stimuli. Implications and limitations are discussed.

Keywords: modern health worries, emotion, valence, arousal, health belief

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Concerns surrounding the deleterious impact of modern life on health and well-being have been around for centuries (Wessely, 1990). One example was the occurrence of railway spine in the 19th century. Railway spine was a condition in which individuals attributed somatic symptoms to railways, a novel technology at that time (Harrington, 1996). Attributing ill health to aspects of modern living was termed modern health worries (MHW) around the turn of the century, and a measure was created (Modern Health Concerns Scale) to facilitate research on this topic (Petrie et al., 2001).

MHW arise when an individual experiences various bodily sensations as a sign of ill-health (Abramowitz et al., 2007; Taylor et al, 2012; Warwick and Salkovskis, 1990). Some of these individuals have become conditioned to attribute these sensations to environmental factors (Koteles & Simor, 2014; Petrie et al., 2001) through routes such as familial modeling (Koteles, Freyler, Kokonyei, & Bardos, 2015) and/or media coverage (Petrie & Wessely, 2002). Once the MHW are learned, the individuals tends to inflate their ill-health risk and vulnerability to aspects of modern life (Koteles & Simor, 2014). Ultimately, this pattern results in a sensitization to health-related concerns (Freyler, Kohegyi, Koteles, Kokonyei, & Bardos, 2013) and associations with self-appraised health.

MHW and Health

Research suggests MHW to be associated with several measures of self-appraised health. For instance, MHW are associated with higher levels of reported somatic symptoms (Bailer, Witthöft, & Rist, 2008; Freyler, Köhegyi , Köteles , Kökönyei , & Bárdos, 2013; Indregard, Ihlebæk, Eriksen, 2013; Kaptein et al., 2005; Petrie et al., 2001; Ozankinci, Boratav, & Moda,

2011), greater self-declared sick leave (Indregard et al., 2013), poorer self-rated health (Köteles & Simor, 2014), and lower quality of life (Rief et. al., 2012). MHW also have been found to be specific to Idiopathic Environmental Intolerances (also known as Multiple Chemical Sensitivity; Bailer et al., 2008), a functional somatic syndrome in which symptoms are attributed to various substances in the environment (e.g., traffic fumes; Sparks, 1999). Thus, MHW are associated with several measures of self-appraised health and well-being.

MHW have also been associated with healthcare utilization (Andersen & Jensen, 2012; Kaptein et al., 2005; Petrie et al., 2001). Individuals high in MHW are particularly interested in complementary and alternative medicine (e.g., herbal supplements; Baliatsas, van Kamp, Hooiveld, Lebret, & Yzermans, 2015; Furnham, 2007; Jeswani, & Furnham, 2010), as they tend to be wary of modern medicine (Furnham, 2007; Johnson & Blanchard, 2006; Köteles & Simor, 2014; Petrie et al., 2001). Thus, it seems plausible that individuals who are high in MHW may not follow medical recommendations and advice. Overtime, persons with high MHW may avoid preventive medical care, leading to significant morbidity and mortality earlier in life, which may increase medical interventions and associated expenditures.

In summary, persons with MHW appear to report poor health and may be at risk for compromised health with a poor prognosis, the latter eventually leading to demands on health care provision. Research suggests a role of emotions in the associations of MHW with self-appraised health (Diefenbach & Leventhal, 1996; Filipkoswki et al., 2010; Spink, Jorgensen, & Cristiano, 2017; Van den Bergh, Brown, Petersen, Witthöft, 2017; Watson & Pennebaker, 1989). Elucidating the role of emotions may enhance interventions aimed at improving an individual's health perceptions through improved emotional regulation skills (Broadbent, 2010; Cameron & Jago, 2008; Diefenbach & Leventhal, 1996; Dreary, 2008; Van den Bergh et al., 2017; Wearden

& Peters, 2008). In this regard, it has been suggested that in order to identify such therapeutic targets, research should identify the specific situations that elicit emotional responses (Shoda, Wilson, Whitsett, Lee-Dussud, & Zayas, 2015). With no prior research investigating the associations of MHW with emotional responses while incorporating situational influences, this study was developed as a useful first step at examining the influence of situations on emotional responding within the context of MHW.

MHW, Emotions, and Valence

Clinicians and researchers have proposed a distinction between trait and state emotions (American Psychiatric Association [APA], 2013; Batson, Shaw, & Oleson, 1992; Larsen, Berntson, Poehlmann, Ito, & Caccioppo, 2010; Spielberger & Reheiser, 2009). Individual differences reflecting a tendency to repeatedly experience a similar emotional response to a variety of stimuli are referred to as traits (Spielberger & Reheiser, 2009). One example is neuroticism, which is a trait reflecting a tendency to experience negative emotions (Costa & McCrae, 1980; Costa & McCrae 1987) and unpleasant feelings across situations (Clark, Watson, & Mineka, 1994; Jorgensen & Richards, 1989; Lommen, Engelhard, & van den Hout, 2010; Watson & Clark, 1984). A growing body of literature suggests that a small ($.09 \leq r \leq .23$; see Cohen, 1992), positive association exists between MHW and neuroticism (Filipkowski et al., 2010; Köteles, Szemersky, Freyler, & Bardos, 2011; Petrie et al., 2001; Rief et. al., 2012; Spink, Green, & Jorgensen, 2014; but also see Furnham et al., 2012; Furnham, 2007). Thus, current evidence suggests MHW are weakly associated with a general disposition to experience unpleasant emotions.

State emotions are transitory fluctuations in emotions (APA, 2013; Batson, Shaw, & Oleson, 1992; Larsen, Berntson, Poehlmann, Ito, & Caccioppo, 2010; Spielberger & Reheiser,

2009). They differ from trait emotions in that they are short-lived, situationally focused, and occur in the present moment due to a specific stimulus or set of related stimuli. State emotions are also related to trait emotions, as the aggregate of these state emotions are believed to be partially reflected in trait emotions (Epstein, 1979; Watson, Clark, & Tellegen, 1988). That is, a given individual's average of state emotions across situations is associated with their self-report of trait emotions. Given that MHW appear to be weakly associated with neuroticism (Filipkowski et al., 2010; Köteles et al., 2011; Petrie et al., 2001; Rief et. al., 2012; Spink et al., 2014), it is plausible that MHW may be associated with state emotional responses that covary with negative affectivity; however, to date no research has investigated the association of MHW with state emotions. Furthermore, since situational characteristics are important in eliciting state emotions, it has been suggested that research should incorporate specific situational characteristics that are believed to evoke the specific state (Shoda et al., 2015; Spielberger, 1985). Investigating the associations of MHW with negative emotions, triggered by specific stimuli (as detailed later, we used images of air pollution), should also control for neuroticism; that is, such specific correlations need to be shown as not being secondary to a general tendency to experience negative affect (i.e., neuroticism).

Emotions and Situations

In order to understand state emotional responses, it has been suggested that research should examine within- and between-person differences on a situation-to-situation basis (APA, 2013; Batson et. al., 1992; Larsen et al., 2008; Mischel & Shoda, 1995; Shoda & Smith, 2004; Shoda et al., 2015). In other words, it is important to examine person by situation interactions (PxS) to understand the contexts in which an individual's state emotions covary with a response variable. In this regard, it is believed that when a person encounters a specific stimuli, the beliefs

they hold associated with the stimuli (e.g., MHW) and associated emotions are activated. Furthermore, research investigating PxS should focus on unitary situational characteristics (e.g., images containing similar content) to help understand linkages between a given situation and the associated emotional responses (Shoda et al., 2015). This specificity is necessary as differences exist in the types of stimuli that will activate an individual's emotional response (Lazarus, 1991), as well as varying degrees in the type of and intensity of emotional response elicited by similar stimuli (Corr, DeYoung, & McNaughton, 2013). Thus, analysis of specific stimulus categories is important for examining PxS and elucidating the contextual and affective reactions associated with MHW.

The PxS literature suggests that MHW would be positively associated with a tendency to experience unpleasant emotions when encountering MHW-related stimuli (cf. Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley, Moulder, & Lang, 2005; Bradley, Sabatinelli, & Lang, 2014; Kuppens, Stouten, & Mesquita, 2009; Lang & Bradley, 2007; Lazarus, 1991) due to the perception of threat to health and well-being (Petrie et al., 2001). Furthermore, given that MHW appear to be weakly associated with neuroticism (Filipkowski et al., 2010; Köteles et al., 2011; Petrie et al., 2001; Rief et. al., 2012; Spink et al., 2014), it seems plausible that MHW would also be associated with emotional responses to negative stimuli (e.g., threats) in general. However, as implicated earlier, such associations of MHW with negative stimuli may be due to the association of MHW with neuroticism. PxS would then suggest that, after controlling for such relevant covariates (e.g., neuroticism), MHW would only be associated with emotional response to MHW-related stimuli.

Research examining such associations may also have clinical implications as state emotions are believed to play a role in perpetuating and maintaining associations with self-

appraised health (Spink et al., 2017; Van der Bergh et al., 2017; Watson et al., 1988). Of particular note, some researchers have implicated state emotional valence (hereafter referred to as valence) as an important factor in the association of self-appraised health outcomes with environmental triggers (e.g., modern technologies; Van der Bergh et al., 2017). Valence is the subjective sense of pleasantness/unpleasantness elicited by a specific stimuli (Lang et al., 1990). To date, no research has examined such associations within the context of MHW; therefore, this study will add to the literature by investigating associations of MHW with valence while incorporating a PxS framework.

Dimensional Perspective of Emotions

A considerable amount of research has used a dimensional perspective to examine the influence of situations on emotional responses (Bradley et al., 1990, 2001, Lang, Bradley, & Cuthbert, 1990). From a dimensional perspective, emotions are composed of two higher order factors, namely, valence and arousal (Bradley et al., 2001). Prior research has identified valence as a key factor linking environmental stimuli (e.g., modern technologies) to self-appraised health outcomes (e.g., somatic symptoms; Van den Bergh et al., 2017). Despite the proposed role of valence, no research has examined the associations of MHW with self-reported valence judgements to varying types of stimuli. Thus, studies examining such associations may spur further clinically-relevant investigations into the role of situationally-based valence on self-appraised health outcomes. Given the previous contributions of this theoretical framework to the elucidation of emotional reactivity and the potential for supporting clinical work and future research, a dimensional perspective was used for this study with valence serving as the primary outcome variable.

Regarding valence, the PxS literature suggests a positive relationship exists between MHW and valence ratings of MHW-related stimuli (i.e., images of air pollution). Nevertheless, MHW appear to be weakly associated with neuroticism (Filipkowski et al., 2010; Köteles et al., 2011; Petrie et al., 2001; Rief et. al., 2012; Spink et al., 2014), and neuroticism is positively associated with ratings of unpleasantness to a range of negative stimuli (e.g., threats; Larsen & Ketelaar, 1991; Raffard, Bortolon, Stephan, Capdevielle, Van der Linden, 2017; Timmermans, Van Mechelen, & Nezlek, 2009; Walter et al., 2011). Thus, MHW may show associations with valence ratings for other negative stimuli (e.g., attacks or contamination; Bradley et al., 1990, 2001, Lang, Bradley, & Cuthbert, 1990) prior to adjusting for neuroticism and the testing for interactions with image content. That is, associations of MHW to valence ratings of other negative stimuli (e.g., attacks or contamination) may be influenced by the associations of these variables with neuroticism (i.e., neuroticism as third variable). After controlling for such relevant factors (neuroticism in particular), PxS predicts that MHW would only be associated with valence ratings for stimuli of modernity (air pollution in the present case) due to PxS match (APA, 2013; Batson et. al., 1992; Larsen et al., 2008; Mischel & Shoda, 1995; Shoda & Smith, 2004; Shoda et al., 2015).

We also conducted exploratory analyses examining arousal as a secondary outcome measure, as its role in self-appraised health is unclear at this time. Arousal represents a tendency to react with varying degrees of emotional intensity when presented with a stimuli (Lang et al., 1990). In other words, higher arousal means a more intense emotional experience. Situations involving threat to life, health and well-being (e.g., pictures of attacks or contamination) are one type of stimuli shown to evoke greater levels of arousal (Bradley et al., 1990, 2001). Given that MHW are beliefs that various aspects of modern life are a threat to health and well-being (Petrie

et al., 2001), it is plausible that a positive association would exist between MHW and ratings of arousal in response to MHW-related stimuli. Neuroticism is also associated with arousal for negative images (Aluja, Rossier, Blanch, Blanco, Marti-Guiu, & Balada, 2015; Walters et al., 2011). Again, given that MHW are associated with neuroticism (Filipkowski et al., 2010; Köteles et al., 2011; Petrie et al., 2001; Rief et. al., 2012; Spink et al., 2014), we examined if MHW would be associated with arousal ratings of other negative stimuli (e.g., attacks or contamination; Bradley et al., 1990, 2001, Lang, Bradley, & Cuthbert, 1990). Similar to valence, associations of MHW to arousal ratings of other negative stimuli (e.g., attacks or contamination) may result due to the associations of these variables with neuroticism (i.e., neuroticism as third variable). After such relevant variables are accounted for, PxS predicts that MHW may only be associated with arousal ratings for stimuli of modernity due to PxS match (APA, 2013; Batson et. al., 1992; Larsen et al., 2008; Mischel & Shoda, 1995; Shoda & Smith, 2004; Shoda et al., 2015).

In summary, MHW may be only associated with valence and arousal ratings of MHW-related stimuli, after controlling for other concomitant variables (neuroticism in particular), due to the person (MHW) and situation (MHW-related images) match. However, in order to investigate such association in the context of PxS, a specific stimulus set needs to be selected (Shoda et al., 2015) designed to be presented in a standardized manner across participants (Lang & Bradley, 2007). In this regard, evidence suggest visual images are a useful first step in such investigations (Bradley et al., 2014; Lang & Bradley, 2007).

MHW, Valence, and Images

Several prior studies have used visual images to investigate state emotional responses to situations (Bradley et al., 2014; Lang & Bradley, 2007; Maehr, Watts, Hanratty, Talmi, 2015;

Thibodeau, Jorgensen, & Jonovich, 2008). In fact, standardized sets of images, such as the International Affective Picture System (IAPS), have been designed to investigate state emotions within laboratory contexts as they can be easily presented in a standardize manner (Lang et al., 2005). Indeed, prior research has demonstrated that images can be useful in laboratory investigations of PxS and emotional responses (Thibodeau, Jorgensen, & Jonovich, 2008).

To date, no research has investigated the association of MHW with ratings of valence and arousal while viewing MHW-related stimuli. One study, though, used a dimensional perspective to investigate differences in state emotional responses between individuals supporting and opposing modern power generating facilities (e.g., wind turbines, nuclear power plants, etc.; Maehr et al., 2015). In this study, several images were shown to individuals differing in their attitudes toward these facilities, and their emotional responses were measured via self-reported valence and arousal. Results suggested that individuals opposing modern power facilities rated the images depicting these facilities as more unpleasant; however, no differences were found in self-reported arousal. Although this study examined aspects of modern life, the assessment of attitudes did not account for individual differences in perceived threat of modernity (i.e., MHW). For instance, the items primarily assessed the perceived aesthetics of power generating facilities, as well as participant's views on global warming. This scale then may not have adequately captured individual differences in the perceived threat of modern life to health and well-being, a factor believed to influence both valence and arousal levels (cf. Bradley et al. 1990, 2001), which may have resulted in underestimates of the associations. Furthermore, these analyses did not control for neuroticism; that is, the authors were unable to determine if the associations were secondary to a predisposition to experience generalized negative emotionality. Thus, further research appears warranted investigating the associations of MHW with emotional responses.

Despite the apparent usefulness of images in examining associations of MHW with valence and arousal ratings to various categories of stimuli, some difficulties are present in implementing such research. First, most of the items composing the Modern Health Concerns Scale, the scale typically used to measure MHW (Petrie et al., 2001), are difficult to display visually (e.g., antibiotics in food, genetically modified food, depletion of the O-zone layer, leakage from microwave ovens, etc.). The selection of specific stimuli is key in order to obtain the specificity required to investigate associations of MHW and valence (see Shoda et al., 2015). Second, current standardized image sets (i.e., the IAPS) do not contain a sufficient number of images to perform such investigations. Given these difficulties, we conducted pilot testing (discussed below) in order to select the images to be used in the current study.

The Current Study

The present study investigated the association of MHW with state emotional response by having undergraduates, with varying levels of MHW, view a series of emotionally laden images. PxS were incorporated by investigating the influence MHW (a person variable) and image content (a situational variable) on emotional ratings; prior research has demonstrated images to be useful in similar investigations (Thibodeau et al., 2008). Furthermore, a dimensional perspective of emotions was used due to the extensive literature using this perspective to investigate emotional responses to images (Bradley et al., 1990, 2001; Bradley, & Cuthbert, 1990; Lang et al., 1990) with emotional valence serving as the primary outcome variable due to its proposed clinical utility (Van den Bergh et al., 2017). To date, no prior research has investigated these distinct aspects of emotions in relation to MHW.

Of note, prior research suggests that gender differences exist in MHW (Andersen & Jensen, 2012; Furnham, 2007) and emotional ratings of images (Bradley & Lang, 2007). More

specifically, this literature suggests that females, as compared to males, tend to report higher MHW, as well as rate unpleasant images as more unpleasant and arousing. Given this evidence suggesting possible gender differences in study variables, we conducted analyses to determine if such differences existed in our sample, and determined that we would control for gender in our analyses if gender influenced study variables.

Hypotheses

Primary outcome. Based on the literature reviewed above, several hypotheses were made. First, a good amount of evidence suggests a small, positive association exists between MHW and neuroticism (Filipkowski et al., 2010; Köteles et al., 2011; Petrie et al., 2001; Rief et. al., 2012; Spink et al., 2014). Therefore, we predicted that MHW would be positively associated with neuroticism. Neuroticism also represents a tendency to experience negative emotions in response to a variety of stimuli (Clark et al., 1994; Costa & McCrae, 1980; Costa & McCrae 1987; Jorgensen & Richards, 1989; Lommen et al., 2010; Watson & Clark, 1984), and is associated with unpleasantness when encountering negative stimuli (Larsen & Ketelaar, 1991; Raffard et al., 2017; Timmermans et al., 2009; Walter et al., 2011). Given the hypothesized association of MHW with neuroticism, we predicted that MHW would be associated with valence ratings for negative images (i.e., attack/threat and contamination/mutilation).

Given the specificity predicted by PxS, we also predicted a significant interaction would be present between MHW and image category, with MHW predicting only valence ratings of air pollution images due to PxS match (APA, 2013; Batson et. al., 1992; Larsen et al., 2008; Mischel & Shoda, 1995; Shoda & Smith, 2004; Shoda et al., 2015). Again, we also examined the covariates of gender and neuroticism to assess whether the expected PxS was independent of these two variates previously shown to correlate with MHW.

Exploratory analyses. We conducted exploratory analyses using arousal as a secondary outcome measure, although our pilot testing and prior research (Maehr et al., 2015) suggests that these analyses would be underpowered to detect significant relationships. First, neuroticism has been found to be associated with arousal when encountering negative stimuli (Aluja et al., 2015; Walters et al., 2011). Given the hypothesized association of MHW with neuroticism (Filipkowski et al., 2010; Köteles et al., 2011; Petrie et al., 2001; Rief et. al., 2012; Spink et al., 2014), we predicted that MHW would be associated with arousal ratings for negative images (i.e., attack/threat and contamination/mutilation). Furthermore, MHW also represent individual differences in the perceived threat of modern life to health and well-being (Petrie et al., 2001), and research suggest that images containing perceived threats typically tend to be more arousing (Bradley et al. 1990, 2001). Similarly, the PxS literature (Batson et al., 1992; Larsen et al., 2008; Mischel & Shoda, 1995; Shoda & Smith, 2004; Shoda et al., 2015), suggests a positive association should exist between MHW and arousal ratings of air pollution images since the perception of threat to self when exposed to the air pollution images should increase with increasing scores of MHW. Thus, we predicted that a positive association would exist between MHW and arousal ratings of air pollution images. Like the valence ratings, neuroticism and gender were used as covariates in testing the PxS.

Methods

This study was part of a larger project designed to examine the associations among MHW, emotions, and health. The materials and procedures associated with this study are detailed in the following sections. The full list of project questionnaires can be found in Appendix B.

Power Analyses

Using a large effect size as indicated by pilot testing (refer to Appendix A), a Type I error rate (two-tailed) of 0.05 and a power of 0.80, it was determined that a minimum of 38 participants would be necessary to analyze the proposed data. However, we collected data from a greater number of participants given the recommendations in the literature to ensure sufficient power (Darlington, 1990; Howell, 2010).

Participants

We collected data from a total of 73 college students who were enrolled in an introductory level psychology course within a college located in the northeastern USA. This sample size is similar in size to that of prior studies that investigated state emotions (Bradley et al., 1992, 2006, 2005; Lang et al., 1993; Thibodeau et al., 2008). Furthermore, participants reported their emotions in responses to eight categories of images contributing up to eight observations per participant. This resulted in 575 total valence ratings and 570 total arousal ratings (out a possible 584 for each) for the proposed analyses. Average age of the sample was 19.17 (SD=1.11) with participants ranging in age from 18 to 24 years. Information regarding the gender, race, and ethnic composition can be found in *Table 1*. As can be seen, the sample was majority white, non-Hispanic, and Female. The following data was collected from all participants.

Materials and Measures

Modern health concerns scale. The Modern Health Concern Scale (see Appendix C) is a 28-item scale designed to assess MHW (Petrie et al. 2001). Items are rated on a 5 point scale from “No Concern” to “Extreme Concern.” Scores range from 28 to 140 with higher scores representing greater MHW. This measure has demonstrated good internal reliability in prior

studies (Petrie et al., 2001; Spink et al., 2014). A growing body of research has demonstrated various factor structures for this measure (see Spangenberg, Rief, Zenger, & Brahler, 2013); however, the research linking MHW to various healthcare outcomes (e.g., self-appraised health and utilization) have used the total score. Thus, to increase the clinical relevance of this study based on the current body of literature, we opted to use the total MHW score. As indicated in *Table 2*, this scale demonstrated good internal consistency in the current sample.

Big five inventory. The Big Five Inventory (BFI) measures the personality traits encompassing the Five Factor Model (John, Donahue, & Kentle, 1991). The psychometrics of this scale have been reported in detail elsewhere (John & Srivastava, 1999). For this study, participants completed the neuroticism scale (see Appendix D). The neuroticism scales consists of eight descriptors, which participants rate on a five point Likert scale from "Disagree Strongly" to "Agree Strongly." Scores range from 8 to 40 with higher scores indicating higher levels of neuroticism. In a prior study in our lab, this measure demonstrated good internal reliability and an association with MHW (Spink et al., 2014). As indicated in *Table 2*, this scale demonstrated good internal consistency in the current sample.

Demographic variables. For this study, participants were asked to report their gender, race, ethnicity, and age. Gender was dummy coded, with females being coded as a zero and males being coded as a one.

Self-assessment manikin (SAM). The SAM (Appendix E; Lang, 1980) was used to assess self-reported valence and arousal for each image. The SAM uses cartoon-like, graphic figures displaying non-verbal cues to assess each dimension, allowing this instrument to be useful with a variety populations (e.g., English speaking and non-English speaking participants; Bradley & Lang, 1994; Ekkekakis, 2013). The SAM has demonstrated convergent validity with

a measure using affective descriptors (the semantic differential rating system; Bradley & Lang, 1994), as well as good reliability (Lang et al., 2005). The ratings are made on a 9-point scale with scores for this study ranging from 6 to 54. To assess valence, participants select the pleasantness/unpleasantness they experience on a scale ranging from pleasant (a smiling face) to unpleasant (frowning face) with higher scores representing more unpleasantness. Arousal is assessed via a similar scale, with images ranging from aroused (exploding figure) to sleepy (eyes closed). We reversed scored the arousal ratings so that higher scores reflected greater arousal. For this study, valence and arousal ratings were collapsed within each image category so that each participant received a valance and arousal rating for each category as has been done in similar research (Thibodeau et al. 2008). As indicated in *Table 2*, within the current sample, this scale demonstrated good internal consistency for valence and arousal ratings across the eight categories of images.

Stimulus images. Forty-eight digital images were used for this study (see Appendix F). Forty-two of these images were chosen from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997), and have been used in prior research within our lab (Thibodeau et al., 2008). The IAPS images are one method for evoking emotional responses within laboratory contexts (Lang & Bradley, 2007). These images encompass several content categories (Bradley & Lang, 2007), allowing for examination of PxS (person-by-content interactions). Similar to prior research (Bradley et al., 2001; Thibodeau et al., 2008), the images were grouped into seven categories, based on image content. The content categories for this study included images depicting: (a) threat/attack, (b) mutilation/contamination, (c) neutral faces, (d) neutral objects, (e) pleasant animals, (f) erotica, and (g) sports/adventure. In order to

determine images representing MHW-related stimuli, we conducted pilot testing prior to conducting the present study.

Pilot testing of MHW images. Initially, Google searches were conducted which identified a total of 63 images representing content for all 28 items of the Modern Health Concern scale (Petrie et al., 2001). None of these images were copy-righted. A total of to 36 undergraduate college student (55% female; 44.4% white) completed the Modern Health Concern Scale and reported the valence and arousal induced by the images via the Self-Assessment Manikan (SAM; Lang, 1980). As can be seen in Appendix A, MHW score were correlated highly with the sum of the valence ratings of all 63 items; however, MHW score were not correlated with arousal ratings. These results are similar to prior research (Maehr et al., 2015) and further support the use of valence as the primary outcome variable, as the pilot testing suggests a significant association should be present.

Given the recommendations in the literature to use a single stimuli type when investigating PxS (Shoda et al., 2015), we aimed to select images with unitary content (e.g., just air pollution) as specificity is necessary to investigate PxS and state emotional reactivity to allow for adequate interpretability (e.g., determining what situational content elicit an emotional response). To reduce the number of images, we examined the descriptive statistics, as well as correlation coefficients of each rating with MHW scores and emotional ratings. First, we examined correlations between each image and the MHW scale, and eliminated any images that were not significantly correlated with MHW scores. This resulted in 38 images being eliminated. Given that the primary outcome measures was valence, we also examined correlations with the total valence score of all 63 items in order to select items that reflected total valence scores. Another two images were eliminated because they were not significantly

correlated with total valence scores. Of the remaining images, only one category of items contributed more than one image, which would allow us to keep with the specificity recommended in the PxS literature (Shoda et al., 2015). Furthermore, it was hoped that the present study would provide a set of MHW-related images to be used in a future startle paradigm (cf. Spink et al, 2014) that would require six images with unitary content (cf.. Thibodeau et al., 2008). Given these considerations, we chose to focus on the air pollution images.

A total of 12 pollution images demonstrated significant correlations between individual's MHW score and valence ratings, $.4 \leq r \leq .7$, $p < .05$. MHW scores were not correlated with arousal ratings for these images, all *p's*>.05. Furthermore, the 12 pollution images demonstrated significant correlations with the sum of valence ratings of the entire 63 images set, $.42 \leq r \leq .72$, $p < .05$. The six required images for this study were chosen by dropping those images with the lowest correlations with MHW scores, as well as removing one image due to low variance. As compared to the other 63 images, the six chosen images all encompassed aspects of air pollution and demonstrated the highest correlations with MHW scores and valence scores of the entire set.

The selection of air pollution images aligns with research suggesting that air pollution is a highly concerning topic (Utah Priorities, 2016), particularly in regards to health (Chen, 2013; Furnham, 2007; Keptein, 2005; Petrie, 2001). We also conducted analyses to determine if worries about air pollution reflected MHW total scores. As indicated in Appendix A, our pilot data suggests that significant associations exists between the air pollution item being highly correlated with both the MHW total score. These results suggests that air pollution scores approximate MHW total score, as well as providing further support for using the images of air pollution in this study.

To further examine the appropriateness of these six images, we examined the internal consistency. The six images demonstrated good alpha coefficients for both valence, Cronbach's alpha= .87, and arousal, Cronbach's alpha= .95. Next, we summed the valence and arousal ratings of the six air pollution images in order to determine if this subscale-score reflected the valence and arousal ratings of the entire 63 images set. As indicated in Appendix A, the valence ratings of the six images of air pollution were highly correlated with the total valence ratings of the entire 63 images. Likewise, the arousal ratings of images of air pollution were highly correlated with the arousal ratings of the entire 63 images. These results provide further support that the valence and arousal ratings of these six air pollution images reflected ratings for all images depicting MHW-relevant stimuli.

Taken together, the results of our pilot testing showed that the six chosen images of air pollution reflected the valence and arousal ratings for MHW-related images and were highly correlated with MHW scores. Prior research further suggest that air pollution is a highly concerning category of MHW, and the present results suggest that the air pollution item are highly correlated with MHW scores. The six air pollution images also contain similar content allowing for PxS investigations. Given these considerations it was decided that the air pollution images would be a suitable stimuli for use in this study.

Procedure

The following procedures were approved by the Institutional Review Board (IRB# 17-143). Data was collected in groups of up to 25 participants, with participants receiving 1.5 hours of course credit in exchange for participation in this study. Upon arrival to the testing room, the study was described to the participants. It was explained that, as part of the investigation, they would view a series images, one at a time, and would report their subjective experiences

following each image. Prior to initiation of data collection, written informed consent was obtained during which participants were informed of the various categories of images they would view during the study. After informed consent, participants completed the Modern Health Concerns Scale and Big Five Inventory neuroticism scale, as well as items querying demographics (i.e., age, race, ethnicity, and gender).

Participants were then given instructions on rating the images. As in prior studies, the images were randomized (see Bradley et al., 2001; Thibodeau et al., 2008) and automatically presented using standard projection equipment to display images. The random order, because it was presented to the total group being tested that day, was not different across participants within each day of testing. That is, because time of testing was determined by the participant's choice, the randomization corresponds to 5 different orders. Before the presentation of each image, a warning slide was presented for five seconds which requested participants to direct their attention to the projection screen. At this point, participants were instructed to ensure the page number in the rating booklet matched the image number which was presented. The image was then presented for six seconds following which participants were instructed to report the valence and arousal they experienced while viewing each image. They were given 20 seconds to make these ratings before being presented with another warning slide. This series continued until participants viewed all images.

Following completions of the study, the participants were debriefed and thanked for their efforts in the study. Similar procedures have been used in prior research within our lab (Thibodeau et al., 2008). A study flow diagram can be found in Appendix G.

Data Analytic Strategy

All data was double entered by two independent coders using a standardized manual. The two data sets were then compared, and discrepancies were resolved by reviewing the information provided on the questionnaire packets and discussion. Data analysis was conducted using IBM SPSS version 24. Refer to Appendix H for description of data analytic plan. We began by examining descriptive statistics and conducting analyses to examine the association of gender and age with MHW, as well as with valence and arousal ratings. Notably, the ethnic and racial composition of our sample, we did not conduct analyses examining racial and ethnic differences as we had extraordinarily low numbers (e.g., fewer than 3 participants) for several groups and the interpretation of such analyses would be unclear. We then examined zero-order correlations to determine if significant associations were present among study variables. Following these analyses, predictors and covariates were then centered per the recommendations of Aiken and West (1991) to reduce multicollinearity. Next, separate repeated measures generalized linear models (GLM) were conducted with valence and arousal ratings as separate outcome variables. In these GLM analyses, MHW was the continuous predictor of interest, with neuroticism, gender and the interaction of gender and MHW entered as covariates. Given the aforementioned gender differences in the predictor and outcome variables, the interaction term between MHW and gender was entered differentially for both the valence and arousal ratings. Furthermore, testing time (hereafter referred to as image presentation order) was dummy coded (corresponding to 4 degrees of freedom) and used to covary out possible confounding related to image presentation order in the GLM analyses.

Results

Descriptive statistics for study variable can be found in *Table 2*. All variables were normally distributed.

Valence Analyses

Demographic associations. To begin, we examined the possible gender differences for MHW, neuroticism, and valence ratings. Age was not correlated with MHW or neuroticism, *r*'s <.10, *p*'s>.41. In the prediction of valence, GLM analyses showed that both the main effect for age, F(5,65) = 2.33,*p*<.05, and it's interaction with image category, F(18.18,232.68) = 1.19, .27, were non-significant. Results from independent samples t-test showed that females scored higher than males in MHW, *t*(71)=2.28, *p*=.02, Cohen's d=0.53; no significant gender differences in neuroticism occurred, *t*(70)=0.512, *p*=.61. To examine the covariation of gender with valence ratings of various categories, a repeated measures GLM was conducted, with results demonstrating that gender did not exert a significant main effect on valence ratings, F(1,68)=0.78, *p*=.38, partial η^2=.01; however, a significant interaction was present between gender and image category, F(3.73, 253.92)=2.82, *p*=.03, partial η^2=.04, *β*=.74, suggesting that the correlations of gender with valence ratings varied across the different image categories. Further analyses suggested that females rated images of attack/threats as more unpleasant than males, *t*(71)=2.93, *p*=.01, Cohen's d=0.68, and images of pleasant animals as more pleasant than males, *t*(70)=2.964, *p*=.004, Cohen's d=0.70. In sum, these results suggested that gender is associated with both MHW and valence ratings of images.

Zero-order correlations. As an initial step, zero-order correlations were computed (see *Table 2)*. Contrary to our hypothesis, MHW were not significantly associated with neuroticism. Other hypotheses were supported, as MHW were significantly associated with valence ratings of air pollution images, as well as negative images (i.e., threat/attack, and mutilation/disgust images); these associations are in the expected directions. MHW did not correlate with the other image categories. However, these analyses do not take into account within sources of variance

nor the covariates. Thus, a repeated measure GLM was conducted to account for these sources of variance.

Repeated measures GLM. First, between-subjects effects were examined to determine if MHW predicted average levels of valence ratings collapsed across categories. The results demonstrated that MHW were not a significant predictor of average valence, $F(1,64)=1.91$, $p=.17$, partial $\eta^2=.03$, $\beta=.28$. Thus, results suggest that MHW do not demonstrate a main effect on valence ratings.

Next, we examined within-subject effects of stimulus category. Results from Mauchley's Test of Sphericity suggested that the sphericity assumption was violated, $\chi\ (27)^2=154.94$, $p<.001$. Thus, we used Greenhouse-Geisser corrections for these within-subject analyses. The within-subjects effect suggested that significant differences due to image category were present, $F(3.90, 249.87)=170.60$, $p<.001$, partial $\eta^2=.73$, $\beta>.99$. As predicted, the interaction of image category and MHW was also significant, $F(3.90,249.87)=3.47$, $p=.009$, partial $\eta^2=.05$, $\beta=.85$. This significant interaction suggest that MHW associations with valence varied across image categories; parameter estimates were examined to determine which categories demonstrated significant associations with MHW. Parameter estimates produced during this analysis can be seen in *Table 3*. These parameter estimates further supported our hypotheses, as MHW remained a significant predictor of valence ratings for only images of air pollution after controlling for neuroticism and gender. Additionally, the three way interaction of MHW, gender, and image category was not a significant predictor of valence ratings, $F(3.90, 249.87)=0.66$, $p=.62$, partial $\eta^2=.01$, $\beta=.21$.

Exploratory Arousal Analyses

Demographic associations. Repeated measures GLM was used to examine the associations of demographic variables with arousal ratings. In the prediction of arousal ratings, gender did not demonstrate a significant main effect, F(1, 65)=.01, p=.92, or significant interaction with image, $F(4.11, 267.46)=0.56$, $p=.70$. Similarly, age did not demonstrate a significant main effect, F(1,62)=2.63, $p=.11$ or interaction with image category in predicting arousal ratings, F(4.15,269.70)=1.53, $p=.19$.

Zero-order correlations. As can be seen in *Table 2*, MHW were significantly associated with arousal ratings for images of air pollution, threat/attack, and mutilation/contamination. Results also show that MHW were a significant predictor of arousal ratings for images depicting neutral faces and erotica. MHW were not associated with arousal ratings for images of neutral objects, pleasant animals, and sports/adventure. Once again, these analyses did not account for within-subject variance and did not control for covariates such as neuroticism and gender.

Repeated measures GLM. First, between-subjects effects were examined to determine if MHW predicted average levels of arousal ratings collapsed across categories. These results suggested that MHW were a significant predictor of average arousal, F(1,61)=8.70, $p=.005$, partial $\eta^2=.12$, $\beta=.83$, with MHW being positively associated with average arousal levels, $r=.31$, $p=.01$. Thus, results suggest that MHW showed a main effect on arousal ratings.

Next, we examined within-subject effects. Results from Mauchley's Test of Sphericity suggested that the sphericity assumption was violated, $\chi (27)^2=137.76$, $p<.001$. Thus, we used Greenhouse-Geisser corrections for these analyses. The within-subjects results suggested that significant differences due to image category were present, F(4.30, 262.17)=13.51, $p<.001$, partial $\eta^2=.18$, $\beta>.99$. The interaction of image category and MHW was also found to be

significant, F(4.30, 262.17)=3.28, p=.01, partial η^2=.05, β=.85. This significant interaction suggest that MHW differentially influenced arousal ratings for the various categories, and parameter estimated were examined to determine which categories demonstrated significant associations with MHW. Parameter estimates produced during this analysis can be seen in *Table 3*, which shows that MHW were a significant predictor of arousal ratings of images from a variety of categories, including images of air pollution, threat/attack, mutilation/contamination, neutral faces, and erotica after controlling for neuroticism and gender. MHW were not a significant predictors of the other image categories. Gender did not demonstrate a significant interaction with image category in predicting arousal ratings, F(4.30, 262.17)=1.04, p=.38.

Discussion

This study is the first to examine the association of MHW with emotional states using a PxS paradigm to investigate reactivity to specific stimulus categories. Regarding primary outcomes, the results supported our hypotheses. First, results suggested that MHW were associated with the experience of unpleasantness across negative stimuli (i.e., threat/attack, and mutilation/contamination) and for images of air pollution, but not associated with valence ratings of the other categories. However, these correlations do not take into account within subject variation or shared variance with covariates (i.e., neuroticism, gender, and order of image presentation). After taking into account within subject variance and parsing out variance due to third variables, our results demonstrated a significant interaction between MHW and image category, with parameter estimates suggesting MHW were only associated with valence ratings for images of air pollution. Taken together, these results suggests that MHW are specifically associated with the experience of unpleasantness when encountering modern stimuli (e.g., air pollution) and, within the context of MHW, provide some support for PxS theory (Mischel &

Shoda, 1995; Shoda & Smith, 2004; Shoda et al., 2015). Specifically, the present results suggests that an understanding of both individual differences and situational characteristics are important when examining association of MHW with state emotional valence.

Contrary to valence ratings, the results derived from the exploratory analyses of the arousal ratings do not support the PxS hypotheses. Although our results showed that MHW are associated with arousal ratings of air pollution and negative images (i.e., threat/attack and mutilation/contamination), they also showed that MHW were associated with arousal ratings for neutral faces and erotica. Similarly to valence, a repeated measures GLM was conducted to examine the influence of within and between-subject variance and control for other relevant variables (i.e., neuroticism, gender, and order of image presentation). These GLM results demonstrated a significant main effect of MHW and interaction of MHW with image category in predicting arousal ratings. Parameter estimates suggest the association of MHW with these image categories persisted. Therefore, the present results suggest that the association of MHW with arousal ratings is not specific to stimuli of modern life, with MHW appearing to be associated with arousal ratings to a variety of categories. These result are rather surprising given that results from the pilot testing and prior research (Maehr et al., 2015), suggesting that MHW would not be associated with arousal ratings. Compared to other studies, the present study had a larger sample size that led to greater statistical power for analyses and the increased accuracy of parameter estimation. This greater power, then, may partially explain the present findings. Taken as a whole, the present results suggest that MHW are associated with the experience of arousal across numerous context; however, given the exploratory nature of the present data, further research is necessary to replicate these results.

Surprisingly, our results did not demonstrate an association of MHW with neuroticism. As noted earlier, some prior studies also found no association of MHW with neuroticism (Furnham et al., 2012; Furnham, 2007), which has spurred research examining individual differences that may moderate this association. In a prior study, the current authors found that the personality construct of openness to experience (hereafter referred to as openness) moderated the association of neuroticism and MHW (Spink et al., 2014), with individuals high in openness not demonstrating associations of MHW with neuroticism. It is believed that qualities of individuals high in openness (i.e., curiosity, novelty seeking, and receptiveness to changes) may attenuate associations with measures of negative emotions (i.e., neuroticism). It is possible that higher levels of openness were present in our sample relative to the other samples which may have partially mitigated this association. However, it should be noted that further research is necessary examining potential moderators of the association of MHW with neuroticism to help determine under what conditions these two variables co-vary.

Implications

Valence has been proposed to be a key factor that influences the association of self-appraised health outcomes with environmental triggers (e.g., modern technologies; Van den Bergh et al., 2017). In fact, research has demonstrated that stimuli an individual perceives as unpleasant are more likely than pleasant stimuli to be associated to somatic symptoms (Van den Bergh, et al., 1999, 2002; Van den Bergh, Stegen, & Woestijne, 1998; cf., Devriese, Winters, Van Diest, & Van den Bergh, 2004). The present results demonstrate a medium (cf. Cohen, 1992) association of valence ratings for the images of air pollution and MHW, which may suggest that individuals high in MHW are more likely to attribute unpleasant physical sensations (e.g., somatic symptoms) to various aspects of modern life. Furthermore, our results suggest that

MHW are associated with self-reported arousal across a number of different stimuli, and arousal is often experienced via various physical symptoms (e.g., increased heart rate; APA, 2013). Thus, it seems plausible that some individuals may experience a tendency toward emotional arousal and associated increases in somatic symptoms while attributing the cause of these symptoms to the stimuli they consider unpleasant. In the context of MHW, the unpleasant stimuli would be elements of modernity based on the present results.

One possible explanation, then, for the association of MHW with self-appraised health outcomes (Bailer et al., 2008; Freyler et al., 2013; Indregard et al., 2013; Kaptein et al., 2005; Köteles & Simor, 2014; Petrie et al., 2001; Ozankinci et al., 2011; Rief et. al., 2012) is through associative processes (cf. Lenaert, Boddez, Vlaeyen, & van Heugten, 2017) linking modern stimuli to poor self-appraised health in individuals high in MHW due to it's the perceived negative valence (Van den Bergh et al., 2017). Associations of somatic sensations, such as physical symptoms, with MHW may function to augment symptom response expectancies (Kirsh, 1985, 1997). Increased response expectancies for physical symptoms may then lead those individual who expect negative health effects to experience greater somatic symptoms (Kirsch, 1985, 1997; Spink et al., 2017) and display greater illness behaviors (e.g., self-declared sick leave, etc.; Lenaert et al., 2017) in response to encounters with the perceived detrimental stimuli (i.e., elements of modern life). Such associations may also provoke avoidance behaviors in attempts to prevent the perceived ill-health effects (Petrie et al., 2005), with these avoidant behaviors also functioning to reinforce the association of MHW with ill health (cf. Skinner, 1947). Thus, it is plausible that symptoms may induce MHW and aspects of modern life may acquire the ability to elicit poorer self-appraised health (e.g., further symptom experience) due to

these valence judgments. Further research, though, is necessary to support the proposed bi-directional relationship.

Given this interplay of cognitions (e.g., MHW) and emotions (e.g., valence and arousal), interventions aimed at altering these factors may be useful at decreasing the associated emotional (Köteles et al., 2011; Köteles and Simor, 2013; Rief et al, 2012) and somatic symptoms (Bailer et al., 2008; Freyler et al., 2013; Indregard et al., 2013; Kaptein et al., 2005; Petrie et al., 2001; Ozankinci et al., 2011). In this regard, cognitive-behavioral treatments may be useful at improving self-appraised health for those high in MHW. Van den Bergh and colleagues (2017) proposed that expectations, attributions, and avoidance behaviors may be useful targets for such interventions, and they identify possible interventions including psychoeducation, exposure to environmental triggers, and interoceptive exposures as potentially helpful techniques. They theorize that such techniques provide the individual with experiences that contradict the expected association, thereby weakening the link of environmental stimuli with self-appraised health. Furthermore, developing the client's emotional regulation capabilities may clients decrease associated emotional arousal (Cameron & Jago, 2008), as well as decrease their experience of negative affect as they encounter aspects of modern life (see Spink et al., 2017 for discussion). However, additional research is necessary to support the efficacy of such interventions in populations high in MHW, as no prior research has examined clinical interventions in such populations.

Limitations

Given the cross-sectional nature of the present data, we are unable to establish time precedence (cf. Kenny, 1979). Similarly, given the correlational nature of the present data, we are unable to infer causality. Thus, we are not able to determine if cognitive variables (i.e.,

MHW) precede feelings of unpleasantness, if unpleasant feelings (e.g., somatic symptoms) lead to the development of MHW, or if a third unknown variable is causing both. Prior research by Crichton and colleagues (2013), though, provide some support for the causal influences of MHW on self-appraised health and mood. These researchers measured mood and physical symptoms before and after administering an experimental manipulation involving infrasound (noise generated from wind turbines). Participants were randomly assigning to view video clips either attributing poorer or improved health to the infrasound. Following the manipulation, participants were then exposed to either infrasound or a sham (no infrasound) condition. Their results demonstrated a main effect for the video clip viewed, with individuals who viewed the video attributing poor health to infrasound reporting significant pre-post increases in physical symptoms and negative mood when compared against the other group. No main effect for infrasound exposure or interaction of infrasound exposure and video clip was found. Although replication of these results is necessary, they provide some evidence for the causal influence of MHW (e.g., concern about noise generated by wind turbines) on the experience of mood. Furthermore, a similar experimental manipulation may be incorporated alongside a PxS image viewing paradigm (similar to the one used in this study) to examine changes in state emotional reactions to various categories of images. Using random assignment alongside experimental manipulations to alter MHW would, then, be better able to parse apart the influence of MHW on state emotional experience to images.

Our focus on exclusively air pollution images is also a limitation, as it is unclear if the associations of MHW with stimuli depicting other aspects of MHW (e.g., genetically modified foods) would elicit similar associations. It is therefore not possible to determine if the present results would generalize to these other stimuli. Our choice to focus on images of air pollution

was made due to the results of pilot testing and the ease in which we could display images of air pollution as compared to other content on the modern health concerns scale (e.g., genetically modified foods). In this regard, using video news clips such as those used by Crichton and colleagues (2013) may provide opportunities to investigate stimuli which are difficult to display via images. Such clips can incorporate verbal explanations that, while adding to the complexity of the stimulus and potentially decreasing internal validity (e.g., decreasing experimental control by introducing other factors like motion and sound), may be useful in investigating different types of stimuli and increasing the generalizability of the present findings. Further research would then be able to determine if the present results generalize beyond the context of air pollution.

Additionally, the present study relied on self-reported measures of valence and arousal to assess state emotional experience. Such measures, then, may be influenced by the individual's immediate affective state upon entry into the study; however, such a measure of initial affective state was not available to adjust for such a covariate. In addition, emotions are multifaceted experiences involving several factors, including cognitive, behavioral, and physiological responses (Barlow, 2004; Bradley et al., 1990, 2001, Lang, Bradley, & Cuthbert, 1990). In fact, we have previously suggested that startle paradigms may be a useful to further investigate the association of MHW state emotions (Spink et al., 2014). Given that this study has demonstrated images can elicit self-reported emotional responses, and that several prior startle studies have used images to investigate startle response (Bradley et al., 1990, 1991, 2001, 2005; Cuthbert et al., 1996; Lang & Bradley, 2007; Lang et al., 1993), a useful next step could be to investigate the association of MHW with state emotional reactivity as indicated by various physiological indicators (e.g., Galvanic Skin Response, electromyography, etc.). Such a study would provide

evidence of the association of MHW with emotions above and beyond that of self-report measures.

The age of the sample is another limitation as the present study was composed exclusively of young adults (age range: 18-24) who most likely have had greater exposure to various items on the Modern Health Concerns Scale (i.e., a cohort effect) which could decrease MHW in this population (Van den Bergh et al, 2017). Research regarding associations of age with MHW has been inconsistent, with some studies suggesting a negative association of MHW with age (Furnham, 2007; Koteles & Simor, 2014; Witthoft & Rubin, 2013), some suggesting a positive association (Andersen et al., 2012; Bailer, Witthoft, & Rist, 2008; Baliatas et al., 2015; Freyler et al., 2013; Koetles et al., 2011, 2012) and others suggesting no association (Koetles et al., 2015; Petrie et al., 2005; Rief et al., 2012; Spink et al., 2014). Thus, the influence of age on MHW is inconclusive, and it is unclear how the young age of the present sample may have influence MHW scores in the present. Conversely, results from one study have demonstrated that older adults tend to perceive negative images as more unpleasant and arousing than young adults (Gruhn & Scheibe, 2008). This tendency to experience greater unpleasantness and arousal when encountering negative images may be due, in part, to a tendency of older adults to rely more on situational triggers (e.g., image content) due to decreased influence by internal triggers (e.g., MHW; Mendes, 2010). This tendency may decrease the specificity demonstrated in the present study. For instance, older adults may not show as strong of an association of MHW with images of air pollution due to the decreased influence of MHW, yet may report higher level of unpleasantness and arousal when reporting on the negative images (e.g., threat/attack and mutilation/contamination) due to increased reliance of the negative situational (image content)

triggers. Further research, though, is necessary examining the influence of age on PxS in regards to MHW.

In summary, the present study is the first to demonstrate that MHW are associated only with valence ratings in response to images depicting aspects of modern life (i.e., air pollution) after controlling for within- and between-subject variance, as well as other relevant factors (i.e., neuroticism and gender). Although MHW were also associated with valence ratings of negative images (i.e., mutilation/contamination and threat/attack), these associations were not significant after controlling for neuroticism and gender. Thus, the present results provide some support for PxS in regards to the association of MHW with emotional valence ratings. On the other hand, , MHW demonstrated a main effect on arousal ratings, and MHW were associated with arousal for several different categories of stimuli, even after controlling for the influences of gender, neuroticism, race, and presentation order. Therefore, arousal results did not support PxS hypotheses.

Table 1
Gender, Race, and Ethnicity Composition of the Sample

Demographic Category	Frequency	Percentage
Gender		
Male	31	42.5
Female	42	57.5
Race		
White	54	74.0
Black	3	4.1
Asian	11	15.1
Mixed Race	3	4.1
Other	1	1.4
Did not report	1	1.4
Ethnicity		
Hispanic/Latino/Latina	10	13.7
Not Hispanic/ Latino/Latina	62	84.9
Did not respond	1	1.4

Table 2

Zero-order Correlation Coefficients, Descriptive Statistics, and Cronbach's Alpha for Study Variables

	Variable Name	1	2	3	4	5	6	7	8	9	10	Mean	SD	Cronbach's Alpha
1	MHW	-	.01 (.93)	.43 (<.001)	.28 (.02)	.25 (.03)	.13 (.28)	.06 (.60)	-.09 (.44)	-.18 (.13)	-.10 (.41)	73.29	21.83	.95
2	Neuroticism	.01 (.93)	-	.10 (.41)	.15 (.22)	-.02 (.86)	.01 (.96)	.13 (.30)	-.02 (.89)	-.05 (.66)	.08 (.53)	23.68	6.77	.86
3	Air Pollution	.39 (.001)	.24 (.05)	-	.44 (<.001)	.44 (<.001)	.31 (.01)	.06 (.62)	-.41 (<.001)	-.15 (.22)	-.19 (.12)	42.87	6.94	.87
4	Threat/ Attack	.28 (.02)	.27 (.02)	.70 (<.001)	-	.56 (<.001)	.29 (.01)	.25 (.03)	-.33 (.01)	.02 (.88)	-.15 (.20)	42.11	4.67	.86
5	Mutilation/ Contamination	.26 (.03)	.23 (.05)	.79 (<.001)	.78 (<.001)	-	.16 (.18)	.16 (.19)	-.36 (.002)	-.05 (.68)	-.27 (.02)	50.92	4.16	.84
6	Neutral Faces	-.31 (.01)	.02 (.88)	-.68 (<.001)	-.50 (<.001)	-.55 (<.001)	-	.59 (<.001)	.22 (.06)	.03 (.80)	.24 (.05)	33.96	5.89	.83
7	Neutral Objects	.14 (.23)	.01 (.92)	.53 (<.001)	.39 (.001)	.35 (.003)	-.72 (<.001)	-	.45 (<.001)	.21 (.08)	.40 (.001)	30.46	4.76	.74
8	Pleasant Animals	.19 (.11)	.07 (.57)	.29 (.02)	.20 (.11)	.11 (.35)	-.35 (.003)	.31 (.01)	-	.08 (.49)	.47 (<.001)	14.57	6.37	.80
9	Erotic	.25 (.04)	.25 (.04)	.61 (<.001)	.67 (<.001)	.59 (<.001)	-.55 (<.001)	.56 (.002)	.43 (<.001)	-	.46 (<.001)	22.35	8.72	.90
10	Sports/ Adventure	.16 (.17)	.06 (.62)	.53 (<.001)	.65 (<.001)	.54 (<.001)	-.50 (<.001)	.48 (<.001)	.37 (.002)	.70 (<.001)	-	20.94	7.04	.82
Mean		73.29	23.68	23.49	33.28	31.40	40.94	17.22	24.17	29.97	32.50			
SD		21.83	6.77	10.80	11.44	11.39	8.94	9.33	12.57	13.36	12.09			
Cronbach's Alpha		.95	.86	.92	.89	.92	.92	.90	.87	.94	.90			

Note: P-values for correlation coefficients are shown in parentheses. Coefficients for valence are displayed above the diagonal, and coefficients for arousal are displayed below the diagonal. SD = Standard Deviation; MHW = Modern Health Worries

Table 3

Parameter Estimates for MHW Predicting Valence And Arousal Ratings Derived From Repeated Measures Generalized Linear Modeling (GLM) Analyses

	Image Categories							
Outcome Measure	Air Pollution	Threat/ Attack	Mut./ Cont.	Neutral Face	Neutral Objects	Pleasant Animals	Erotica	Sports/ Adv.
Valence	0.14	0.08	0.03	0.06	0.01	0.005	-0.08	-0.03
	(.001)	(.08)	(.18)	(.11)	(.62)	(.88)	(.12)	(.42)
	[.16]	[.05]	[.03]	[.04]	[.004]	[<.001]	[.04]	[.01]
Arousal	0.20	0.26	0.15	-0.12	0.10	0.09	0.18	0.12
	(.002)	(.02)	(.02)	(.02)	(.05)	(.19)	(.02)	(.11)
	[.15]	[.09]	[.08]	[.09]	[.06]	[.03]	[.09]	[.04]

Note: These analyses controlled for neuroticism, gender, the interaction of gender and MHW, and image order presentation. Betas are shown with *p*-value in parentheses and partial η^2 in brackets. MHW = Modern Health Worries; Mut./Cont.= Mutilation/Contamination; Sports/Adv. = Sports/Adventure

Appendix A

Results from Pilot Testing

Correlation coefficients

		1	2	3	4	5
1	MHW Total Score	-				
2	Air Pollution Item	.73*	-			
3	Valence total all images	.63*	.39*	-		
4	Valence for six selected air pollution images	.74*	.65*	.86*	-	
5	Arousal for all images	.04	.09	-.10	.01	-
6	Arousal for six selected air pollution images	.14	.30	.05	.21	.91*

*p <.05

Appendix B

Full List of Study Questionnaires

Demographics

Big Five Inventory (BFI)

Buss-Perry Scale

Center for Epidemiologic Studies Depression Scale (CES-D)

Generalized Anxiety Disorder – 7 Item Scale (GAD-7)

Marlow-Crowne Social Desirability Scale

Modern Health Concerns Scale

Multidimensional Experiential Avoidance Questionnaire (MEAQ)

Patient Health Questionnaire-15 (PHQ-15)

Spielberger State-Trait Anxiety Inventory (STAI)

Disgust Scale-Revised (DS-R)

Discrete Emotions Scale*

Self-Assessment Manikin (SAM)*

*Indicates scales presented to measure emotional responses to images

Appendix C
Modern Health Concern Scale

These days many people worry about the effects of different aspects of modern life on health. Please rate the following items for how much you are concerned about their effect on your personal health:

		No concern	A little concern	Moderate concern	High concern	Extreme concern
1.	Cell Phones	1	2	3	4	5
2.	Radio or Cell phone towers	1	2	3	4	5
3.	High Tension Power Lines	1	2	3	4	5
4.	Nuclear radiation	1	2	3	4	5
5.	Air Pollution	1	2	3	4	5
6.	Noise pollution	1	2	3	4	5
7.	Depletion of the Ozone Layer	1	2	3	4	5
8.	Traffic fumes	1	2	3	4	5
9.	Other Environmental Pollution	1	2	3	4	5
10.	Pesticide spray	1	2	3	4	5
11.	Poor building ventilation	1	2	3	4	5
12.	Genetically Modified Food	1	2	3	4	5
13.	Additives in Food	1	2	3	4	5
14.	Pesticides in Food	1	2	3	4	5
15.	Antibiotics in Food	1	2	3	4	5
16.	Hormones in Food	1	2	3	4	5
17.	Mad cow disease (CJD)	1	2	3	4	5
18.	Contaminated Water Supply	1	2	3	4	5
19.	Fluoridation of Water	1	2	3	4	5

Appendix C (continued)

Modern Health Concerns Scale

		No concern	A little concern	Moderate concern	High concern	Extreme concern
20.	Vaccination Programs	1	2	3	4	5
21.	Overuse of Antibiotics	1	2	3	4	5
22.	Toxic Chemicals in Household Products	1	2	3	4	5
23.	Leakage from Microwave Ovens	1	2	3	4	5
24.	Bacteria in Air Conditioning Systems	1	2	3	4	5
25.	Drug Resistant Bacteria	1	2	3	4	5
26.	Amalgam dental fillings	1	2	3	4	5
27.	Medical and dental X-Rays	1	2	3	4	5
28.	Bio-terrorism (e.g. anthrax poisoning)	1	2	3	4	5

Appendix D

Big Five Inventory – Neuroticism Subscale

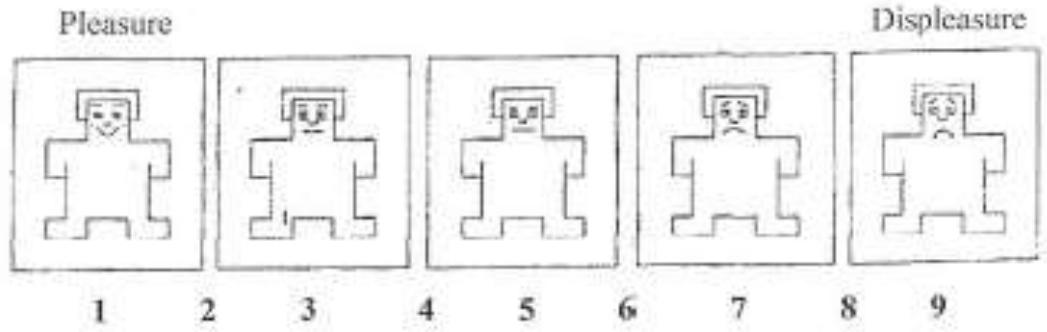
Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

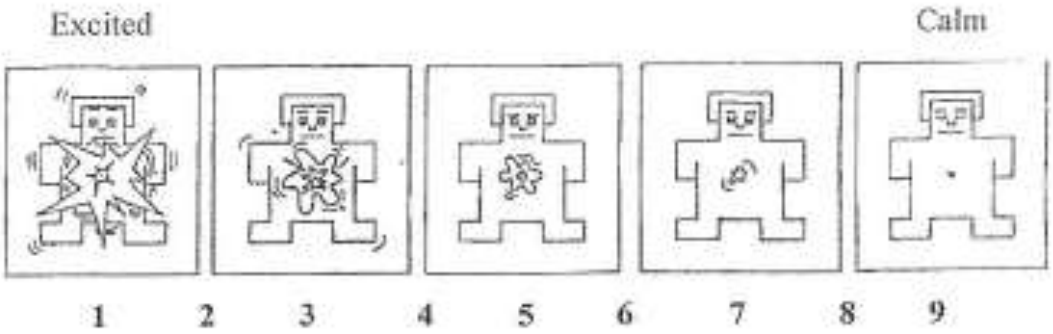
Questions	Disagree strongly		↔		Agree strongly
Is depressed, blue	1	2	3	4	5
Is relaxed, handles stress well	1	2	3	4	5
Can be tense	1	2	3	4	5
Worries a lot	1	2	3	4	5
Is emotionally stable, not easily upset	1	2	3	4	5
Can be moody	1	2	3	4	5
Remains calm in tense situations	1	2	3	4	5
Gets nervous easily	1	2	3	4	5

Appendix E

Self-Assessment Manikin (SAM)

Please indicate how the picture makes you feel while viewing it:





Appendix F

Images by Category

Pollution Images






Threat/Attack Images



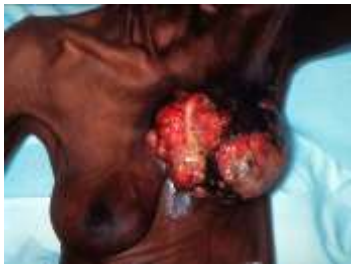



Appendix F (continued)

Images

Mutilation/Contamination Images






Neutral Faces Images






Appendix F (continued)

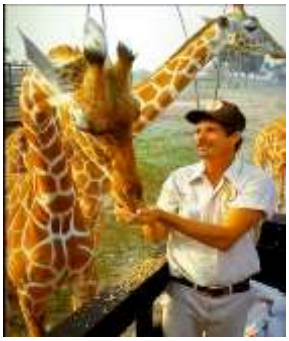
Images

Neutral Objects Images






Pleasant Animals Images






Appendix F (continued)

Images

Erotica Images






Sports/Adventure Images






Appendix G

Study Flow Diagram

Participant check-in

↓

Introduction to research staff and study

↓

Informed consent

↓

Completion of self-report questionnaires

↓

Viewing of images followed by ratings

↓

Debriefing

Appendix H

Data Analytic Plan

Step #	Description
1	Examined descriptive statistics.
2	Make necessary adjustments to ensure normality.
3	Examined for demographic effects including gender, racial and ethnic influences, and correlations with age.
4	Examined zero-order correlations among study variables, namely MHW, neuroticism, and valence and arousal ratings for each of the eight categories.
5	Conduct two repeated measures GLM using valence (primary) and arousal (exploratory) as separate outcome measures. MHW (continuous) was the predictor of interest in the model with, neuroticism (continuous), image presentation order (categorical), gender (categorical), and the interaction of gender and MHW being covariates. Between subject effects were used to determine if main effects were present and within-subject effects were used to determine if the variables differentially predicting emotional ratings for different groups (see Howell, 2010)

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