Scandinavian Journal of Psychology, 2011, 52, 174–178 DOI: 10.1111/j.1467-9450.2010.00846.x

Personality and Social Psychology

Somatosensory amplification as a possible source of subjective symptoms behind modern health worries

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Köteles, F., Szemerszky, R., Freyler, A. & Bárdos, G. (2011). Somatosensory amplification as a possible source of subjective symptoms behind modern health worries. *Scandinavian Journal of Psychology 52*, 174–178.

The theoretically hypothesized connection between modern health worries (MHWs) and somatosensory amplification (SSA), as well as the factor structure of the Hungarian version of the MHW scale were investigated in a cross-sectional questionnaire study. A total of 163 university students (mean age = 21.3± 2.70 yrs; 44.2% male) and 145 patients (mean age = 49.4±17.51 yrs; 31.7% male) visiting their general practitioners (GPs) completed questionnaires assessing MHWs, SSA, subjective somatic symptoms (PHQ-15), and trait anxiety (STAI-T). The previously described four-factor structure of the MHW scale was confirmed using confirmatory factor analysis (CFA). In the linear regression analysis, participants' age and SSA scores were positively related to MHWs even after controlling for gender, anxiety, and subjective somatic symptom scores. The conclusions are that: MHWs are indicators of cognitive, behavioral and social level of sensitization for health-related concerns; SSA can provide the somatic background process for generation and/or misattribution of subjective somatic symptoms; better understanding of the cognitive-emotional background of MHWs could help to determine possible interventions.

Key words: Nocebo, non-specific symptoms, symptom misattribution, idiopathic environmental intolerance.

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INTRODUCTION

Despite the improvement of the objective health status over the past decades, people's perception of subjective health has worsened (Barsky, 1988; Filipkowski, Smyth, Rutchick *et al*., 2009). Among other factors (e.g. stress), concerns about the possibly harmful nature of the features of modern life have been increased (Page, Petrie & Wessely, 2006). The perceived risk to personal health from technological changes and from features of modern life was called modern health worries (MHWs; Petrie, Broadbent, Kley, Moss-Morris, Horne & Rief, 2005; Petrie, Sivertsen, Hysing *et al*., 2001). MHWs, as assessed by the MHW scale, were classified into four major groups (subscales): Environmental pollution (e.g. contaminated water supply), Toxic interventions (e.g. amalgam dental fillings), Tainted food (e.g. additives in food), and Radiation (e.g. cell phones). This structure has been reproduced in several national (English, Dutch and German) versions of the MHW scale using exploratory factor analysis (PCA; J. Bailer, Bähr, Stübinger & Witthöft, 2008a; Kaptein, Helder, Kleijn, Rief, Moss-Morris & Petrie, 2005; Petrie *et al*., 2001). For testing the factorial validity of a theoretical construct (a hypothesized model), however, confirmatory factor analysis (CFA) is a more appropriate method. To the authors' knowledge, only one study has used this method on an internet-based German community sample, and the hypothesized four-factor structure of the MHW scale was confirmed (Bailer, Witthoft & Rist, 2008b).

A considerable portion of worries about modernity is not without a good reason, but concerns and fear are enhanced disproportionally by the popular media and by other sources (Filipkowski *et al*., 2009; Bailer *et al*., 2008a; Petrie *et al*., 2001). The greater attention to health triggers and enhances the feeling of personal vulnerability (Petrie & Wessely, 2002) and distracts attention from factors that can be personally influenced or controlled (e.g. health style; Petrie *et al*., 2001). Expectations of negative health consequences can lead to physical symptoms: this is called the nocebo phenomenon (Hahn, 1997). Possible mechanisms of symptom generation are the enhancement and misattribution of normal bodily feelings or of physiological changes generated by anxiety (Barsky, 1979; Barsky & Borus, 1999), perceptual biases (Lees-Haley & Brown, 1992), or introspection and selective searching for symptoms (Barsky, Goodson, Lane & Cleary, 1988; Pennebaker, 1982). A complex mechanism called cognitive causation was proposed by Bailer and his colleagues (Bailer *et al*., 2008b): high levels of MHWs lead people to focus on bodily sensations and to enhance these sensations, which in turn reinforces the perceived causal relationship between symptoms and environmental agents.

Nocebo effects have been defined as side effects of placebos in clinical trials (Kennedy, 1961). A considerable proportion of drug side effects can also be due to the nocebo phenomenon, and similar mechanisms of symptom generation have been described (Barsky, Saintfort, Rogers & Borus, 2002). In that case, biochemical and psychosocial (i.e. ''specific'' and ''non-specific'') factors can even interact and enhance each other (Barsky *et al*., 2002), and similar mechanisms and interactions might play a role in the generation of symptoms attributed to the features of modern life (Petrie *et al*., 2005; Petrie & Wessely, 2002).

MHWs have proven to be good predictors of health-related complaints, subjective somatic symptoms, and utilization of health

care services in several studies (e.g. Filipkowski *et al*., 2009; Bailer *et al*., 2008a; Kaptein *et al*., 2005; Petrie *et al*., 2001, 2005). On the other hand, our knowledge regarding the personality background of individuals with MHWs is rather poor.

The association with negative affect is an obvious possibility and was indeed demonstrated in several studies (e.g. Filipkowski *et al*., 2009; Bailer *et al*., 2008a; Petrie *et al*., 2001) but rejected in others (e.g. Kaptein *et al*., 2005; Petrie *et al*., 2005). In the study of Furnham (2007), none of the Big Five personality traits were related to MHWs.

Proneness to somatization (defined as a tendency to express emotional dysphoria as somatic symptoms; Spinhoven & van der Does, 1997) is another possible background factor. There are stable personal differences among healthy people in their propensity to generating somatic symptoms (Kroenke, 2006) which are not explainable from a biomedical point of view (Barsky *et al*., 2002; Brown, 2006). People with symptoms of uncertain origin (often called medically unexplained symptoms, MUS) frequently seek reasonable causes for their problems (labeling), and may find an obvious explanation by the exaggerated dangers of modern life (Kaptein *et al*., 2005; Petrie *et al*., 2005).

Negative affect and somatization tendency are mainly emotion-related traits. From a theoretical point of view, however, MHWs should have a pronounced cognitive component (Bailer *et al*., 2008a) which cannot be accessed via the above constructs. From the literature of health psychology, one more candidate emerges which is strongly related to symptom reports and to the nocebo phenomenon: somatosensory amplification (SSA), the tendency to enhance somatic feelings and sensations (Barsky, 1979; Barsky *et al*., 1988). According to recent results, SSA refers not to low-level differences in processing of sensory input (Aronson, Barrett & Quigley, 2001; Nakao & Barsky, 2007) but to some kind of cognitive bias in interpreting symptoms that reach consciousness (Mailloux & Brener, 2002). One of the key features of SSA is the heightened attention and focus on bodily sensations (Barsky *et al*., 1988), and it is strongly related to trait anxiety and to general worry (i.e. the cognitive aspects of anxiety) as well as to hypochondriacal beliefs and to cross-sectional symptom reports (Aronson *et al*., 2001; Barsky *et al*., 1990; Nakao & Barsky, 2007). Consequently, people with high SSA scores show an enhanced emotional response to their somatic feelings which serves as the basis of the biased cognitive interpretation of these sensations. Based on these characteristics, SSA may be an excellent "all-in-one" construct to access the often-mentioned vicious circle of self-monitoring and anxiety (Barsky, 1979). This mechanism might also be a characteristic of MHWs, since health-related concerns trigger anxiety together with its somatic correlates (Bailer *et al*., 2008a). Moreover, in several questionnaire and experimental studies, SSA has proven to be a significant predictor of subjective symptoms attributed to drugs (Köteles & Bárdos, 2009a, 2009b) or to sham electromagnetic fields (Szemerszky, Köteles, Lihi & Bárdos, 2009), respectively. Considering these results, the association between MHWs and SSA seems to be a feasible assumption.

The aims of the present study were (1) confirming the four-factor structure of the MHW scale using CFA, and (2) demonstrating the assumed association between MHWs and somatosensory amplification.

METHOD

Participants

Two groups were included in the study. The first group consisted of 163 volunteer undergraduate university students from the Eötvös Loránd University, Budapest, Hungary (mean age = 21.3 years, *SD* = 2.70; 44.2% male). The second sample included patients (*N* = 145) visiting their GPs for whatever reason (mean age = 49.4 years, *SD* = 17.51; 31.7% male). In terms of educational qualifications, 20.6% of the latter group was low level (elementary school), 54.6% medium level (high school), and 24.8% high level (at least university degree). Students completed the questionnaire in groups in their classrooms. Patients were asked to participate in the waiting rooms of their GPs. Participants filled out the questionnaires anonymously and they did not receive any financial or educational reward for their participation. Nine patients refused to participate in the study.

Questionnaires

Modern Health Worries (MHW, Petrie *et al*., 2001) is a 25-item scale that measures people's concerns of modernity affecting their health. The extent of perceived health threats (e.g. amalgam dental fillings, overuse of antibiotics or air pollution) were rated on five-point Likert scales from "no concern" to "extreme concern". The Hungarian version of the scale was created as a consensus on two independent translations (accomplished by F.K. and Gy.B.) and was checked by back translation into English. The scale has a stable, well-interpretable factor structure and good internal reliability (Bailer *et al*., 2008a, 2008b). The internal consistency of the Hungarian version was quite high, 0.93 and 0.96 in the student and patient samples, respectively. Cronbach's α values for the four subscales ranged between 0.79 and 0.93 in the two samples, indicating a high degree of homogeneity among items.

The *Trait Anxiety Inventory* (STAI-T; Spielberger, Gorsuch & Lushene, 1970) is a widely used, valid and reliable 20-item questionnaire that measures the general level of anxiety on four-point scales. The internal consistency of the Hungarian version (Sipos, Sipos & Spielberger, 1994) was 0.88 and 0.91 in the two samples, respectively.

The *Patient Health Questionnaire Somatic Symptom Severity Scale* (PHQ-15; Kroenke, Spitzer & Williams, 2002) is a 15-item scale designed to measure the prevalence of the most common body symptoms (e.g. headache, insomnia) experienced in the last four weeks. It covers 14 of the 15 most prevalent DSM-IV somatization disorder symptoms and it is also proposed as a diagnostic tool for a new and broader category of somatoform disorders (PSD – Physical Symptom Disorder; Kroenke, 2006). The Cronbach α coefficients were 0.61 and 0.83 for the two samples in the present study.

The *Somatosensory Amplification Scale* (SSAS; Barsky *et al*., 1988; Barsky, Wyshak & Klerman, 1990) is a scale that refers to the tendency to experience a somatic sensation as intense, noxious, and disturbing. The SSAS evaluates sensitivity to mild bodily sensations that are uncomfortable and unpleasant, but not pathological. It consists of 10 self-rated statements that are estimated on a five-point scale. The Hungarian version proved to

be valid and psychometrically sound (Köteles, Gémes, Papp *et al*., 2009), its internal reliability was 0.74 and 0.80 in the two groups of the present study.

Data analysis

Questionnaire total scores were calculated as sums of item scores. To control for participants' age, means of the two samples were compared by analysis of covariance (ANCOVA) with age as a covariate. Student samples were compared by unpaired two-sample *t*-test. Correlations among personality variables were calculated using Pearson's correlation coefficients. Variables were subjected to a multiple linear regression analysis with the MHW score as dependent variable. In Step 1, demographic control variables (group affiliation, age, education) were entered into the equation, then (Step 2) gender, (Step 3) trait anxiety, (Step 4) subjective somatic symptoms, and finally (Step 5) somatosensory amplification scores. The factor structure of the MHW scale was checked by confirmatory factor analysis (CFA) using the AMOS program (v 4.01). As the χ^2 value (CMIN) is overly sensitive to sample size, a corrected index (DMIN/df) was used to test model fit. Model fit was also assessed with a widely used absolute fit index (root mean square error of approximation – RMSEA) that compares the observed data with the proposed model and with incremental fit indices that compare the observed data with a baseline model (normed fit index – NFI, Tucker-Lewis index – TLI, comparative fit index – CFI).

RESULTS

Factor structure of the Hungarian version of the MHW scale

Data of the two samples fit quite well to the hypothesized four-factor model (CMIN = 1296.071, df = 538, CMIN/df = 2.409, $p < 0.001$; NFI = 0.929; TLI = 0.948; CFI = 0.957; RMSEA = 0.068). Factor loadings of the MHW items are summarized in Table 1.

Table 1. *Standardized factor loadings for confirmatory factor analysis of the MHW scale in the two groups*

Items	Students	Patients
MHW1 -> Factor1	0.437	0.703
MHW2 -> Factor1	0.655	0.711
MHW3 -> Factor1	0.705	0.647
MHW4 -> Factor1	0.565	0.495
MHW5 -> Factor1	0.668	0.711
MHW6 -> Factor1	0.687	0.840
MHW7 -> Factor1	0.467	0.800
MHW8 -> Factor1	0.603	0.703
MHW9 -> Factor1	0.709	0.719
MHW10 -> Factor1	0.647	0.659
MHW11 -> Factor1	0.555	0.524
MHW12 -> Factor2	0.809	0.839
MHW13 -> Factor2	0.754	0.797
MHW14 -> Factor2	0.725	0.855
MHW15 -> Factor2	0.877	0.858
MHW16 -> Factor2	0.877	0.857
MHW17 -> Factor2	0.786	0.795
MHW18 -> Factor3	0.725	0.844
MHW19 -> Factor3	0.776	0.789
MHW20 -> Factor3	0.798	0.890
MHW21 -> Factor3	0.849	0.841
MHW22 -> Factor3	0.762	0.809
MHW23 -> Factor4	0.809	0.872
MHW24 -> Factor4	0.935	0.967
MHW25 -> Factor4	0.661	0.859

Table 2. *Descriptive statistics (means and SDs) of questionnaire data in the two groups*

Scale	Students	Patients
MHW	62.0 (17.07)	67.9 (20.69)
SSAS	27.9 (5.48)	23.1 (7.04)
STAI-T	42.6 (8.26)	44.8 (9.95)
PHQ-15	21.5 (3.48)	22.0 (5.49)

Notes: MHW: Modern Health Worries scale; SSAS: Somatosensory Amplification Scale; STAI-T: State-Trait Anxiety Scale; PHQ-15: Patient Health Questionnaire Subjective Somatic Symptom Severity Scale.

Personality correlates of MHWs

Descriptive statistics of questionnaire data for the two groups are summarized in Table 2. According to the results of ANCOVAs, students' mean MHW value was significantly lower than patients' value ($F(1) = 7.58$, $p < 0.01$) even after adjusting for age. No significant differences were found in the cases of SSAS ($F(1) = 0.042$, $p = 0.84$), STAI-T ($F(1) = 0.004$, $p = 0.95$), and PHQ-15 ($F(1) = 0.853$, $p = 0.357$) scores. Means of SSAS and STAI-T scores did not differ significantly from data obtained in a Hungarian study using two similar samples (Köteles *et al*., 2009). On the other hand, significant differences were found in the PHQ-15 scores. Mean of the student sample was significantly higher ($t(344) = 5.392$, $p < 0.001$) than in the previous study ($M = 18.23$, $SD = 7.01$), whereas mean of patient sample was lower ($t(700) = 3.369$, $p < 0.001$) than in the other study ($M = 23.81$, $SD = 5.83$). Mean MHW value of the student sample did not differ significantly ($t(593) = -8.97$, $p > 0.05$, $d = -0.05$) from a US student sample ($M = 62.95$, $SD = 18.21$; Filipkowski *et al*., 2009). Correlations among the measured personality variables are presented in Table 3.

In the multiple linear regression analysis, all five equations were statistically significant, the final equation explained 14.5% of the total variance ($p < 0.001$). STAI-T score (included in Step 3) had a significant association with MHWs until the PHQ-15 score was entered (Step 4). In the final equation (Step 5), age and SSA were significantly related to MHWs even after adjusting for age, gender, STAI-T and PHQ-15 scores (see Table 4 for details).

DISCUSSION

The major findings of this study are: (1) the four-factor structure of the Hungarian version of the MHW scale was confirmed using confirmatory factor analysis (CFA) on two groups (students and patients), (2) MHWs are strongly associated with age and with somatosensory amplification (SSA).

The previously described (Bailer *et al*., 2008a, 2008b; Kaptein *et al*., 2005; Petrie *et al*., 2001) four-factor structure of the MHW scale was confirmed on two different samples, one of which

Table 3. *Pearson correlation coefficients among measured personality variables*

	MHW	SSAS	STAI-T	PHQ-15
MHW	1	0.24**	0.20*	0.18*
SSAS	*0.29***	1	0.33***	0.28***
STAI-T	*0.17**	*0.41****	1	0.41***
PHQ-15	*0.24***	*0.40****	*0.53****	1

Notes: Upper triangle of the table: student group; lower triangle(marked by italic): patient group. MHW: Modern Health Worries scale; SSAS: Somatosensory Amplification Scale; STAI-T: State-Trait Anxiety Scale; PHQ-15: Patient Health Questionnaire Subjective Somatic Symptom Severity Scale.
* $p < 0.05$; **$p < 0.01$; *** $p < 0.001$.

Table 4. *Parameters of the five steps of the multiple linear regression analysis*

Variable	B (SE)	ß
Step1		
sample	−1.120 (3.535)	−0.29
age	0.228 (0.092)	0.230*
education	−1.125 (2.442)	−0.029
Step2		
sample	−1,636 (3.569)	−0.042
age	0.230 (0.092)	0.232*
education	−1.016 (2.444)	−0.026
gender	2.509 (2.425)	0.064
Step3		
sample	−1.616 (3.530)	−0.042
age	0.208 (0.091)	0.210*
education	−0.347 (2.431)	−0.009
gender	1.395 (2.436)	0.036
STAI	0.336 (0.129)	0.163**
Step4		
sample	−0.873 (3.516)	−0.023
age	0.193 (0.090)	0.194*
education	0.234 (2.424)	0.006
gender	−0.183 (2.512)	−0.005
STAI	0.188 (0.143)	0.091
PHQ-15	0.674 (0.294)	0.165*
Step5		
sample	2.368 (3.519)	0.061
age	0.199 (0.088)	0.201*
education	0.655 (2.361)	0.017
gender	−0.867 (2.450)	−0.022
STAI	0.055 (0.143)	0.026
PHQ-15	0.423 (0.293)	0.104
SSAS	0.792 (0.202)	0.266***

Notes: Dependent variable: MHW score. $R^2 = 0.046$ for Step 1; $\Delta R^2 = 0.004$ for Step 2 ($p > 0.1$); $\Delta R^2 = 0.025$ for Step 3 ($p < 0.05$); $\Delta R^2 = 0.019$ for Step 4 ($p < 0.05$); $\Delta R^2 = 0.052$ for Step 5 ($p < 0.001$).
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

consisted not of university students but patients with a broad range of age and educational qualifications. As it seems from these results, perceived threats of modernity are organized in very similar structure in people's mind in modern societies.

In the present study, older age was positively related to MHWs in all steps of the regression analysis, which agrees with the findings of Bailer and his colleagues (2008b). In a representative New Zealand study (Petrie *et al*., 2001), however, younger persons had more frequent MHWs.

MHWs were more frequent among patients than among students even after controlling for age. A possible explanation for this finding is that people with illness insight are more prone to worry about possible additional threats to their health than are students, and MHWs are typical representatives of such threats.

The lack of difference between patients' and students' somatic symptom scores is not easy to elucidate. As students' data were obtained in February, the remarkably high prevalence of transient somatic symptoms could be the consequence of a hard academic period or a local contagious disease.

Regarding personality variables, significant but low to medium level (0.17–0.29) correlations among MHWs and somatosensory amplification, trait anxiety and subjective somatic symptom scores were found in both groups (Table 3). As the three above-mentioned variables are closely related to each other by negative affect (Costa & McCrae, 1985; Spinhoven & van der Does, 1997), they were entered separately into the regression equation. In Step 3, only trait anxiety was included, and it proved to be significantly related to MHWs (Table 4). In Step 4, this association was lost by entering the subjective somatic symptoms scores. SSA had an even better explanatory power, as the statistical significance of the association between MHWs and somatic symptom scores disappeared by its entering in Step 5.

People with high SSAS scores have a marked cognitive predisposition to monitor themselves for symptoms, and actually experience somatic symptoms as more intensive (Barsky *et al*., 1988). They may be disturbed more by any kinds of symptoms, thus they may have a stronger motivation to avoid harmful influences and to monitor their environment for possible sources of danger. Possibly harmful features of modern life pose such a threat.

Moreover, symptoms of uncertain origin trigger attribution (labeling) processes, and amplifiers have more (and more disturbing) symptoms to attribute. Somatoform or functional syndromes (e.g. Idiopathic Environmental Intolerance, IEI) are characterized by sensitization at somatic, cognitive, behavioral, and social levels (Verkuil, Brosschot & Thayer, 2007). The MHW phenomenon can serve as a good example for the latter three, but attribution processes clearly need a somatic background. In other words, if there is nothing to label, no labeling process will take place. SSA can provide such a (perceived) somatic background, as it increases the prevalence and magnitude of subjective somatic symptoms. From this point of view, the supposedly harmful effects of features of modern life can serve as a possible explanation for the subjective somatic symptoms. In the prospective study of Petrie and his colleagues (Petrie *et al*., 2005), MHWs predicted symptoms attributed to pesticide spraying and preventive behavior but not total symptom scores.

Regarding symptom reports, the direction of causality is always a difficult question. According to the results of Petrie *et al*. (2005), the attribution side of the coin seems to be more pronounced in the case of MHWs, and cognitive causation (symptom generation via increased attention to internal sensation) described by Bailer and his colleagues (2008b) may play a less important role.

The most important weakness of the present study is its cross-sectional design. To describe the cognitive-emotional background of MHWs and the direction of causality, more specific and more sophisticated (preferably experimental) investigations would be

necessary. Moreover, as SSA is related not only to trait anxiety but also to illness worry (Aronson *et al*., 2001), the latter may play a mediating role between SSA and MHWs. In contrast with illness worry, MHWs refer not to a particular disease but to a possible threat, and it is reasonable to speculate that people preoccupied with fears of a serious disease try to avoid additional threats. As illness worry was not assessed in the present study, this possibility cannot be excluded.

As MHWs can have a strong negative impact on the quality of life and well-being, a better understanding of these processes could be an important step toward determining possible interventions.

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Received 15 January 2010, accepted 2 June 2010