

SOMATOSENSORY AMPLIFICATION ABSORPTION CONTRIBUTE TO ELECTROSENSITIVITY

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SZOMATOSZENZOROS AMPLIFIKÁCIÓ, ABSZORPCIÓ ÉS ELEKTROMÁGNESES HIPERSZENZITIVITÁS

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Background – Two trait-like characteristics, somatosensory amplification and absorption, have been associated with symptom reports and idiopathic environmental intolerances in past research.

Purpose – As the two constructs are not connected with each other, their independent contribution to symptom reports and electromagnetic hypersensitivity, as well as their interaction can be expected.

Methods – On-line questionnaire.

Patients – 506 506 college students completed an on-line questionnaire assessing absorption, somatosensory amplification, negative affect, somatic symptoms, and electromagnetic hypersensitivity.

Results – Somatosensory amplification ($\beta = 0.170$, $p < 0.001$) and absorption ($\beta = 0.128$, $p < 0.001$) independently contributed to somatic symptoms after controlling for gender and negative affect ($R^2 = 0.347$, $p < 0.001$). Similarly, somatosensory amplification (OR = 1.082, $p < 0.05$) and absorption (OR = 1.079, $p < 0.01$) independently contributed to electromagnetic hypersensitivity after controlling for somatic symptoms, gender, and negative affect (Nagelkerke $R^2 = 0.134$, $p < 0.001$). However, no interaction effects were found.

Discussion – Somatosensory amplification and absorption independently contribute to symptom reports and electromagnetic hypersensitivity.

Conclusion – The findings suggest that psychological mechanisms underlying symptom reports and electromagnetic hypersensitivity might be heterogeneous.

Keywords: *absorption, somatosensory amplification, electromagnetic hypersensitivity, nocebo, medically unexplained symptoms*

Célkitűzés – Korábbi kutatások alapján a tünetészleléshez és a különféle idiopathiás környezeti intoleranciákhoz két vonásjellegű jellemző, a szomatoszenzoros amplifikáció és az abszorpció is kapcsolódik.

Kérdésselvetés – Mivel a két vonás kevés átfedést mutat egymással, feltételezhető egyrészt az, hogy függetlenül járulnak hozzá mind a tünetek észleléséhez, mind az elektromágneses hiperszenzitivitáshoz, másrészt az is, hogy kölcsönhatásba léphetnek egymással.

A vizsgálat módszere – Online kérdőíves vizsgálat.

A vizsgálat alanyai – 506 egyetemi hallgató töltött ki egy kérdőívcsomagot, ami a szomatoszenzoros amplifikációs tendenciát, az abszorpciót, a negatív affektivitást, a mindennapi testi tüneteket, valamint az elektromágneses hiperszenzitivitást mérte.

Eredmények – A lineáris regressziós elemzésben mind a szomatoszenzoros amplifikáció ($\beta = 0,170$, $p < 0,001$), mind az abszorpció ($\beta = 0,128$, $p < 0,001$) kapcsolódott a mindennapi tünetekhez, a nem és a negatív affektivitás kontrollálását követően is ($R^2 = 0,347$, $p < 0,001$). Mind a szomatoszenzoros amplifikáció (OR = 1,082, $p < 0,05$), mind az abszorpció (OR = 1,079, $p < 0,01$) szignifikánsan hozzájárult az elektromágneses hiperszenzitivitáshoz a testi tünetek, a nem és a negatív affektivitás kontrollálását követően is (bináris logisztikus regressziós elemzés, Nagelkerke $R^2 = 0,134$, $p < 0,001$). Interakciós hatást egyik elemzésben sem találtunk.

Következtetések – A szomatoszenzoros amplifikáció és az abszorpció egymástól függetlenül járulnak hozzá a tünetészleléshez. A tünetriportok és az elektromágneses hiperszenzitivitás mögött többféle pszichológiai mechanizmus húzódnak meg.

Kulcsszavak: *abszorpció, szomatoszenzoros amplifikáció, elektromágneses hiperszenzitivitás, nocebo, orvosiilag megmagyarázatlan tünetek*

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A considerable proportion of symptoms that patients report to their physicians cannot be explained by pathophysiological processes, and thus are considered medically unexplained symptoms (MUS)^{1, 2}. For the cases when MUS show characteristic patterns and become chronic, such as chronic fatigue syndrome and fibromyalgia, the term functional somatic syndromes was proposed¹. The overlaps among these syndromes with respect to symptoms and comorbidities are so large that their integration into a single diagnostic category was also suggested³.

Idiopathic environmental intolerances (IEI) can be regarded as a facet of MUS⁴. Their most distinct feature is that symptoms are attributed to various environmental factors (e.g. chemicals or electromagnetic fields) which do not impact the majority of the population. This is why these conditions have originally been called hypersensitivities, e.g. multiple chemical hypersensitivity or electromagnetic hypersensitivity. Later, as provocation studies did not support the causal role of the suspected factors in the maintenance of the respective conditions^{5, 6}, the use of the etiologically more neutral idiopathic environmental intolerance was suggested⁷. Research in the area today focuses primarily on possible psychological (top-down) etiological factors, for example classical conditioning or expectations (nocebo phenomenon)^{8, 9}.

As the impact of psychological factors on MUS appears substantial, exploration of stable (trait-like) personality characteristics that are reliably associated with these conditions might be helpful to better understand the phenomenon. Two characteristics related to symptom reports are female gender and negative affectivity¹⁰. The former was explained on a psychobiological basis (basically as an interaction between biological features and cultural factors), while the latter was understood as a special cognitive bias^{11, 12}.

Somatosensory amplification (SSA), the proneness to experience somatic sensation as intense, noxious, and disturbing, is associated with both symptom reporting and negative affect¹³. As it is also linked to body focus, SSA was formerly conceptualized as a blend of body focused attention and negative affect (or anxiety) which leads to the enhancement and misinterpretation of body signals^{13, 14}. Recently, it has been suggested that sensitivity to threats to the integrity of the body would be a better explanation¹⁵, and SSA is not characterized by higher levels of sustained attention¹⁶. The role of SSA in nocebo related symptom reports was demonstrated¹⁷. Moreover, SSA was associated with IEI attributed to electromagnetic fields (IEI-EMF) and predicted symptom reports in both actual and sham electromagnetic fields^{9, 18}.

Another trait-like characteristic reliably associated with symptom reports is absorption. Absorption is the tendency to become immersed in external (sensory) and internal (memories, imagination) experiences which often leads to altered states of consciousness¹⁹. Its most important feature is “total attention”, i.e. when the available representational capacity is entirely dedicated to experiencing and modelling the object in focus¹⁹. In consequence, the experience or sensation in focus will be amplified at the expense of other representations. One can also be absorbed in neutral body sensations, such as breathing, as well as symptoms^{19, 20}. Thus, absorption tendency might play a role in experiencing and reporting of symptoms⁸. In empirical research, absorption was associated with various forms of IEI^{21, 22}.

According to the empirical findings from studies where SSA and absorption were assessed simultaneously, the two traits are not ($r = 0.15$)²³ or only weakly ($r = 0.25-0.26$, $p < 0.05$)^{21, 24} connected with each other. This raises the possibility that they might independently contribute to symptom reports. Moreover, their interaction is also possible, i.e. those with high levels on both constructs would show disproportionately more symptoms.

In the current study, six hypotheses were tested as follows. It was expected that both SSA and absorption would be independently associated with somatic symptoms (H1 and H2, respectively). Moreover, their interaction was also assumed (H3). Similarly, the independent contribution of SSA (H4) and absorption (H5) to IEI-EMF and their interaction (H6) were also hypothesized.

Method

PARTICIPANTS

The questionnaires were completed on-line in Hungarian. Participants were undergraduate university students ($N = 506$; age: 20.1 ± 1.67 yrs; 22.8% female) following studies in economics or engineering at Budapest University of Technology and Economics. They received no reward for their participation. The study was approved by the Research Ethical Committee of the university (Approval Nr.: 2016/077), participants signed an informed consent form before completing the questionnaires.

QUESTIONNAIRES

Negative affect (NA), the general dimension of subjective distress and unpleasurable engagement, was assessed using the NA scale of Positive and Negative

Table 1. Descriptive statistics (mean±standard deviation values) of and Pearson correlation coefficients between the assessed variables (n = 506)

	M±SD	Somatosensory amplification	Negative affect	Somatic symptoms
Absorption	17.14±6.770	0.26***	0.11*	0.25***
Somatosensory amplification	27.28±5.569		0.35***	0.37***
Negative affect	20.98±6.264	–		0.46***
Somatic symptoms	6.19±4.23	–	–	

Note: * : p < 0.05; ***: p < 0.001

Affect Schedule (PANAS)²⁵. The NA scale consists of ten items, which are evaluated on a 5-point Likert scale (1: *not at all* ... 5: *extremely*) with respect to the last 4 weeks. Higher total scores refer to higher levels of NA. Internal consistency (Cronbach's α) of the NA scale in the present study was 0.84.

The prevalence and intensity of subjective somatic symptoms were assessed using the Patient Health Questionnaire Somatic Symptom Severity Scale (PHQ-15)². The PHQ-15 is a 15-item scale designed to measure the prevalence of the most common body symptoms on a 3-point Likert scale (0: *not bothered at all* ... 2: *bothered a lot*) with respect to the last 2 weeks; it was also proposed as a diagnostic tool for a new and broader category of somatoform disorders. The Hungarian version showed good psychometric properties in previous studies²⁴, its Cronbach's α coefficient was 0.76 in the present study.

Somatosensory amplification, i.e., the tendency to experience somatic sensation as intense, noxious, and disturbing, was measured using the Somatosensory Amplification Scale (SSAS)^{13, 26}. The SSAS is a 10-item scale, items are rated on a 5-point Likert scale (1: *not at all* ... 5: *extremely*). Higher scores refer to higher levels of amplification tendency. Internal consistency of scale was 0.67 in the present study.

Absorption, i.e. the openness to absorbing and self-altering experiences, was assessed using the Tellegen Absorption Scale (TAS)^{19, 24}. The scale consists of 34 items rated in a binary (yes or no) scale; higher scores indicate higher absorption tendency. Cronbach's α coefficient was 0.86 in the present study.

STATISTICAL ANALYSIS

Statistical analysis was carried out using the SPSS v21 software. Variables' associations were estimated by Pearson-correlation. To analyze their hypothesized interactions, the SSAS and TAS scores were centered (i.e. the respective mean was subtracted from the individual scores for all participants), and an interaction term was calculated as the product of the

two centered values. Hypothesis 1 and 2 were checked using multiple linear regression analysis with PHQ-15 score as criterion variable. Predictor variables were entered using the ENTER method in three steps: (Step 1) gender and negative affect as control variables, (Step 2) SSAS and TAS scores, and (Step 3) the interaction term. Hypothesis 3 and 4 were investigated with a binary logistic regression analysis with IEI-EMF score as criterion variable. Predictor variables were entered using the ENTER method in three steps: (Step 1) gender, negative affect, and PHQ-15 score as control variables, (Step 2) SSAS and TAS scores, and (Step 3) the interaction term.

Results

Descriptive statistics and correlation coefficients are presented in **Table 1**. Absorption showed weak connections with SSAS, NA, and PHQ-15 scores. Similarly, SSA was weakly associated with NA and PHQ-scores. 10.5% of participants (53 individuals) categorized themselves as being hypersensitive to electromagnetic fields.

In the multiple linear regression analysis, both SSAS and TAS scores significantly contributed to somatic symptom score even after controlling for gender and negative affect. However, their interaction term was not significant. The final equation explained 34.7% of the total variance (p < 0.001) (for details, see **Table 2**).

Concerning IEI-EMF, the significant contributions of both SSA and absorption were found in the binary logistic regression equation after controlling for gender, negative affect, and somatic symptoms. Similar to the previous analysis, the interaction term proved to be non-significant (for details, see **Table 3**).

Discussion

In a cross-sectional study with the participation of 506 young healthy adults, somatosensory amplification and absorption independently contributed to somatic

Table 2. Regression coefficients in the three steps of the multiple linear regression analysis with somatic symptom score as criterion variable

	Step 1 R ² = 0.296 p < 0.001			Step 2 ΔR ² = 0.050 p < 0.001			Step 3 ΔR ² = 0.002 p = 0.223		
	B ± SE	95% CI	Standardized β	B ± SE	95% CI	Standardized β	B ± SE	95% CI	Standardized β
Gender	2.993±0.381	2.244–3.742	0.297***	2.548±0.376	1.810–3.286	0.253***	2.545±0.375	1.807–3.282	0.252***
Negative affect	0.279±0.026	0.229–0.329	0.413***	0.234±0.026	0.182–0.285	0.346***	0.234±0.026	0.182–0.285	0.346***
Somatosensory amplification	–	–	–	0.129±0.030	0.070–0.189	0.170***	0.132±0.030	0.072–0.192	0.174***
Absorption	–	–	–	0.080±0.024	0.034–0.127	0.128**	0.079±0.024	0.033–0.125	0.126**
Somatosensory amplification x absorption	–	–	–	–	–	–	0.005±0.004	0.003–0.013	0.044

Note: ** : p < 0.01; ***: p < 0.001

symptoms and IEI-EMF. However, their interaction was not supported by the analysis in either case.

Concerning subjective somatic symptoms, both female gender and higher levels of negative affect showed a significant contribution. These findings are in accordance with previous empirical results and models of symptom perception^{10, 27}. In line with our research hypothesis, both somatosensory amplification and absorption contributed to symptom reports even after controlling for the aforementioned variables. For SSA, this finding supports the notion that, contrary to past proposals²⁸, the construct is not equal to negative affect and has additional explanatory power in the understanding of symptom reports¹⁵. Although absorption showed a weak association with negative affect, SSA, and symptom reports in the correlation analysis, its contribution to symptoms remained significant after controlling for the former two constructs. This supports the idea that the underlying psychological mechanisms are different: SSA represents a primary (automatic) evaluation process, while absorption refers to a non-evaluative submersion in the somatic experience. The lack of interaction between the two constructs is also in accordance with this concept, as the above described psychological mechanisms are rather incompatible with each other. In our view, high levels of absorption reflect a special information-processing style favouring emotionally- and perceptually-driven, associative processes over conventional, verbally structured evaluative processes. This way, absorption can similarly amplify positive and negative experiences depending on

the content of the representation. On the other hand, SSA reflects “categorical” interpretations of mainly adverse, bodily sensations. In this sense, the content of the representation (i.e. bodily sensations) is fundamental and determines the adverse experiences that are measured by SSA.

As hypothesized, SSA and absorption also contributed to IEI-EMF even after controlling for symptoms, the most salient feature of the condition. IEI-EMF refers to a functional somatic syndrome (i.e. a characteristic pattern of symptoms that is attributed to a well-defined environmental factor), which appears to be more serious and threatening than individual symptoms. Therefore, its association with SSA after partialling out symptoms can be explained by the threat perception approach¹⁵. Concerning absorption, it was proposed that electromagnetic hypersensitivity can be considered as an overvalued idea, i.e. a strong preoccupation (still not a delusion) that is not supported by available evidence²⁹. As attention can be occupied with internal images and fantasies, the overvalued idea approach can explain the finding that absorption remains connected with IEI-EMF even after controlling for symptoms.

Understanding the psychological factors underlying symptom reports and electromagnetic hypersensitivity might also contribute to the development of treatment protocols. For instance, the identification of the role of somatosensory amplification in relation to adverse experiences and false beliefs could be crucial to the development of personalized cogni-

Table 3. Regression coefficients in the three steps of the binary logistic regression analysis with IEI-EMF as criterion variable

	Step 1 Nagelkerke R2 = 0.056 p = 0.003		Step 2 Nagelkerke R2 = 0.134 p < 0.001		Step 3 Nagelkerke R2 = 0.134 p < 0.001	
	B ± SE	OR (95% CI)	B ± SE	OR (95% CI)	B ± SE	OR (95% CI)
Gender	0.265±0.345	1.304 (.663–2.563)	0.127±0.353	1.135 (0.568–2.266)	0.128±0.353	1.136 (0.569–2.271)
Negative affect	0.032±0.025	1.033 (.983–1.086)	0.022±0.027	1.022 (0.970–1.077)	0.022±0.027	1.022 (0.970–1.077)
Somatic symptoms	0.076±0.037	1.078* (1.003–1.160)	0.031±0.039	1.031 (0.955–1.113)	0.030±0.039	1.031 (0.954–1.113)
Somatosensory amplification	–	–	0.079±0.031	1.082* (1.019–1.149)	0.076±0.032	1.079* (1.013–1.150)
Absorption	–	–	0.076±0.024	1.079** (1.030–1.131)	0.074±0.026	1.077** (1.024–1.133)
Somatosensory amplification x absorption	–	–	–	–	0.001±0.004	1.001 (0.993–1.009)

Note: IEI-EMF: idiopathic environmental intolerance attributed to electromagnetic fields; * : p < 0.05; **: p < 0.01

tive behavior therapies that focus on the correction of maladaptive schemas and automatic negative evaluations. Similarly, a patient prone to absorption might benefit from treatments using guided imagery and positive suggestions.

The current study has shortcomings that limit its generalizability. Most importantly, a non-representative and special sample (university students) was used. Second, no conclusions can be drawn about causality due to its cross-sectional design. Finally, the assessment of IEI-EMF with only a single yes-or-no question is also criticized³⁰.

Keeping these limitations in mind, this is the first study that assesses SSA and absorption simultaneously in the context of symptom reports and IEI-EMF. The findings indicate that very different psychological mechanisms can lie behind both phenomena. Thus, their etiology and phenomenology can be heterogeneous as well.

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Conclusion

Somatosensory amplification and absorption independently contribute to symptom reports and electromagnetic hypersensitivity. This suggest that the underlying psychological mechanisms might also be heterogeneous.

Declaration of interest: none.

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