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Responsiveness to direct verbal suggestions and dissociation independently predict symptoms associated with environmental factors

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Abstract

Symptoms associated with environmental factors (SAEF; also known as idiopathic environmental intolerance) include the presentation of various common symptoms that are causally attributed to normally benign environmental triggers, such as electromagnetic fields (EMF), odours, and chemicals. SAEF are typically conceptualized as psychogenic in origin and multiple models have proposed that dissociation and responsiveness to suggestions may contribute to the manifestation or expression of these symptoms. This pre-registered study sought to characterize these variables' independent and interactive predictive utility. Participants (N=294) completed psychometric measures of dissociative tendencies, trauma, SAEF, and a behavioral scale indexing responsiveness to direct verbal suggestions. Moderation analyses were used to evaluate predictions derived from different models regarding whether these variables would uniquely and interactively predict individual differences in the reporting of SAEF. Responsiveness to verbal suggestions individually predicted SAEF but no clear evidence was observed for an interaction with dissociation or trauma. Dissociation similarly individually predicted SAEF with additional evidence that this association was moderated by trauma such that the positive association between dissociation and SAEF was only significant in those with moderate-to-high trauma exposure. These results align with the proposal that environmental factors may function as suggestions that trigger involuntary symptoms in some individuals. Our findings further suggest that among individuals with a history of trauma exposure, those with dissociative tendencies may be at an increased risk of experiencing SAEF.

Keywords: idiopathic environmental intolerance; psychogenic; somatic symptom; verbal suggestion
1. Introduction

Symptoms associated with environmental factors (SAEF) include the reporting of symptoms in response to perceived exposure to chemicals, electromagnetic fields, and other environmental stimuli (also known as idiopathic environmental intolerance and encapsulating multiple chemical sensitivity) [1] [2, 3]. Symptomatology varies considerably but often includes headaches, asthenia, sleep disturbances, pain, skin conditions, and cognitive and emotional difficulties [3, 4]. The prevalence of SAEF varies from 2 to 10% of the population but may actually be higher due to underreporting and a tendency to attribute symptoms to other, non-environmental factors [2, 3]. SAEF can lead to disruptive behaviors such as social isolation (e.g., relocating to minimize exposure to environmental triggers) and removing triggering stimuli and have overlapping phenomenology with multiple conditions including functional neurological disorder and somatoform disorders [5].

SAEF are typically conceptualized as psychogenic in origin and multiple models have proposed that suggestions (communications for involuntary changes in behavior and perception) contribute to the manifestation or expression of these symptoms [6]. Previous research has shown that individuals experiencing SAEF are more prone to symptoms in response to suggestions that specific (benign) stimuli will trigger symptoms [7-9], in a similar manner to functional neurological disorder, which is characterized by elevated direct verbal suggestibility including in response to suggestive symptom induction protocols [10, 11]. The reporting of SAEF, and germane nocebo responses, such as hypochondrial concerns, is also associated with absorption [6, 2], a form of dissociation that is frequently associated with suggestibility [9]. A role for suggestion in this condition similarly aligns with predictive processing models of SAEF, which attribute symptoms to the overweighting of precise symptom priors relative to sensory evidence, such as relying more on expectations pertaining to a specific environmental context or a specific cue [2]. Nevertheless, it remains unclear whether SAEF are accompanied by elevated suggestibility and whether this effect is independent of dissociative tendencies. Moreover, it is also unknown whether suggestibility functions as a diathesis that confers risk to SAEF in those exposed to traumatic events, as suggested in other research [12, 9]. To address these gaps in current knowledge, we
contrasted competing moderation models of the associations among suggestibility, trauma exposure, dissociation and SAEF in a non-clinical sample.

2. Methods

2.1. Participants

300 individuals (age range: 18-65, \(M=35.3, SD=11.3\); education range [years of university education]: 0-19, \(M=3.3, SD=3\); sex assigned at birth: female=201, male=92, unavailable=7) provided informed consent to participate in this study in accordance with ethical approval. Participants were recruited through Prolific (www.prolific.co) a web-based participant recruitment platform that allows individuals to anonymously complete a wide-range of online studies for compensation. Participants were limited to UK residents between ages 18 and 65, those fluent in English, and those who have a Prolific rating >95% and who have completed at least five previous studies on Prolific. The sample size was determined \textit{a priori} (90% power, \(\alpha=.05\), two-tailed, \(r\geq.19\)) as described in the pre-registration (https://osf.io/rsfny) and optional stopping was not used (for full methodological details, see Supplement).

2.2. Measures

The \textit{Environmental Symptom Attribution Scale} (ESAS) is a 40-item self-report measure of the extent to which participants attribute health symptoms to environmental sources including electromagnetic fields (EMF), sounds, locations, and odours \cite{13}. The ESAS-global scale exhibited strong internal consistency (40 items; Cronbach’s \(\alpha:.92\)) and all subscales displayed acceptable internal consistency (EMF: 10 items, \(\alpha=.74\); sound: 9 items, \(\alpha=.76\); building-related: 13 items, \(\alpha=.77\); odours: 8 items, \(\alpha=.67\)).

The \textit{Traumatic Experiences Checklist} (TEC) is a self-report scale that measures exposure to potentially traumatic events, including actual or threatened bodily harm to self or others, emotional neglect, and abuse, as well as physical and sexual abuse \cite{14}. The TEC has strong psychometric properties \cite{14} \cite{15} and displayed good internal consistency (\(\alpha=.80\)).
The *Dissociative Experiences Scale-II* (DES-II) is a self-report measure of dissociative tendencies [16]. Along with total scores, the DES-II yields three subscale scores: dissociative amnesia (8 items), absorption (9 items), and depersonalization-derealization (6 items). The DES-II has demonstrated strong test-retest reliability and construct-validity [16] and had strong internal consistency in the present sample (αs: DES-II=.93; amnesia=.77; absorption=.89; depersonalization-derealization=.82).

The *Brief Suggestibility Scale* (BSS) is a behavioral measure used to measure responsiveness to direct verbal suggestions [17]. Through headphones, participants listened to six verbal suggestions delivered by a female voice actor followed by behavioural tests. All suggestions were drawn from hypnotic suggestibility scales and include suggestions for arm heaviness, a dream, one’s hands moving together, eye catalepsy, arm paralysis, and a music hallucination [18-20]. Participants subsequently rate their responsiveness to each suggestion based on their behavioral response using a continuous visual analog scale (0-1) with the aid of explicit behavioural anchors and their experience of involuntariness (0=did not experience at all, 1=voluntary to 5= involuntary [21]) in order to capture the classic suggestion effect and correct for compliance [22]. Both measures demonstrated acceptable internal consistency (αs: behaviour=.71; involuntariness=.75). Behavioural scores were corrected for compliance by computing the mean of z-transformed behavioural and involuntariness scores (BSS-composite score [BSS-C]).

2.3. Procedure

Participants were recruited through Prolific and the measures were implemented through Qualtrics (www.qualtrics.com). After reviewing an information sheet and providing informed consent, participants provided demographic information and completed the four measures in random order. One catch question was included in each measure. Any participant who made one or more errors on catch questions was excluded from the analyses. After completion of the study, participants received a debriefing and were subsequently compensated at a rate of £5/hour.
2.4. Statistical analyses

The methods and data analyses for this study were fully pre-registered (osf.io/vc4fx) and all data are publicly available (osf.io/hca6g). Aside from the ESAS, there were no missing data on any of the measures. On the ESAS, at least one data point was missing for 63 participants (21%) corresponding to <1% of the data. Missing data points were estimated using multiple imputations. Four univariate outliers \( (Z > 3) \) and two multivariate outliers (Mahalanobis distance, \( p < .001 \)) were identified and omitted from subsequent analyses, resulting in a final sample of 294 participants. Due to positively skewed data, DES-II, ESAS, and TEC scores and their subscale scores were log-transformed. Assumptions related to residuals, distribution normality, linearity, homoscedasticity, multicollinearity, and independent errors were all met. SPSS (IBM, v. 26; [23]) was used to conduct moderation and moderated-moderation analyses using Hayes’s PROCESS macro (v. 3.1, [24]) with the HC3 correction for heteroscedasticity (HC3) [25]. 95% Confidence intervals were estimated using Bootstrap resampling (5,000 samples). The Johnson-Neyman technique was used to compute the range of significance and simple slopes analyses [26]. Reported coefficients are unstandardized [24] and analyses were two-tailed, using conventional significance thresholds (\( \alpha = .05 \)).

3. Results

All variables were significantly interrelated except BSS-C and TEC (shown in Fig. 1 and Supplement Table 1). Simple moderation analyses evaluated main effects and two-way interactions between BSS-C, DES, and TEC on ESAS-global scores (Supplement Figure 1). All models were statistically significant and accounted for 10 to 15% of the variance in scores (Supplement Table 2). BSS-C positively predicted ESAS-global scores independently of both DES and TEC, \( b = 0.18-0.21, s^2 = .06-.08, p < .001 \), but did not significantly interact with either. By contrast, DES and TEC interacted in the prediction of ESAS-global scores, \( b = 0.13, s^2 = .02, p = .009 \), with simple slopes analyses indicating that the association between DES and ESAS-global scores was only significant for medium-to-high trauma exposure, low trauma: \( b = 0.10, p = .14 \), medium: \( b = 0.20, p < .001 \), high: \( b = 0.31, p < .001 \) (shown in Fig. 1).
Figure 1. Associations among symptoms associated with environmental factors (SAEF; ESAS-global scores) and predictors. (a) Correlation matrix depicting correlation coefficients between BSS-C, DES, TEC, and ESAS-global scores; (b) regression model depicting the prediction of ESAS-global scores by BSS-C and the DES × TEC interaction (see text for coefficients); and (c) simple slopes depicting how trauma (TEC) scores moderate the association between DES and ESAS-global scores. BSS-C: Brief Suggestibility Scale-Composite; DES: Dissociative Experiences Scale; TEC: Traumatic Experiences Checklist; ESAS: Environmental Symptom Attribution Scale

** p<.01  
*** p<.001

A moderated-moderation analysis evaluating whether the three predictors interacted, replicated the significant effects of BSS-C and the DES × TEC interaction on ESAS-global scores with comparable effect sizes without any additional significant interactions (Supplement Table 2) and further analyses observed similar results with ESAS subscales (Supplement Tables 3-4). In order to derive a more parsimonious model, we evaluated an exploratory regression model with BSS-C and DES as predictors of ESAS-global scores (Supplement Table 5), with the latter moderated by TEC. This model was significant, $F(4, 289)=14.85, p < .001, R^2=.17$, accounting for 17% of the variance in ESAS-global scores (shown in Fig. 1), with significant effects ($p<.01$), of BSS-C, $b=0.18, sr^2=.07$, DES, $b=0.14, sr^2=.03$, and DES × TEC, $b=0.14, sr^2=.02$, but not TEC, $b=0.07, sr^2=.00$. Further exploratory analyses suggest that the
observed effects were specific to dissociative absorption and depersonalization-derealization, thereby potentially implicating detachment-specific effects, as opposed to compartmentalization effects [27, 28].

4. Discussion

These results demonstrate that SAEF reporting is elevated among those who are highly responsive to direct verbal suggestions. This corroborates proposals that suggestibility confers risk to SAEF [6] and aligns with research demonstrating atypical suggestibility in functional neurological disorder and germane conditions [29-31, 11, 32]. Dissociative tendencies, particularly experiences of dissociative absorption and depersonalization-derealization, were also reliable predictors of SAEF; these effects were independent of, albeit weaker in magnitude than, the predictive utility of suggestibility. Our results further indicate that dissociative tendencies interact with trauma in the prediction of SAEF such that dissociation is more strongly associated with SAEF in those with high trauma exposure. However, these suggestibility and trauma-dissociation effects on SAEF were mostly independent: in contrast with a diathesis-stress model [33, 11], we did not find evidence for the proposal that suggestibility confers risk for SAEF in response to trauma.

Contemporary models propose that SAEF arise from the interaction of misinformation regarding environmental toxins, the formation of conditioned stimulus-symptom associations and precise symptom priors, preoccupation with environmental cues and somatic amplification, and cue-symptom triggering [2, 34, 3]. An elevated capacity to respond to suggestions may drive SAEF at multiple stages in this model: highly suggestible individuals may be more likely to believe in environmentally-mediated symptoms due to potential misinformation; they may be more prone to anomalous symptoms and context-mediated somatosensory amplification; and/or they may be more responsive to symptom triggers. A common thread through these different stages is that atypical suggestibility may be characterized by a capacity to form precise symptom priors (e.g., expectations) that are overweighted relative to sensory information, resulting in anomalous symptoms [27, 28, 2, 7, 35, 36]. It will be important for further research to better disentangle how suggestibility and dissociation differentially impact these processes, with potential
implications for heterogeneity in the mechanisms and phenomenology of SAEF. In addition, it will be necessary to extend these results using experimental symptom induction paradigms [6, 8, 9, 3] in patients reporting severe environmental symptomatology.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

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Statement of Ethics
This study protocol was reviewed and approved by the Research Ethics Committee of the Department of Psychology of Goldsmiths, University of London on 1 July 2020. All the participants provided written informed consent to participate in the study.

Author Contributions
Madeline V. Stein contributed to study design, data analyses, drafting the paper and integration of suggested revisions from co-authors of the final version. Rebecca Holt contributed to study design, data collection, and approval of the final paper. Lillian Wieder contributed to study design, paper revisions, and approval of the final version. Devin B. Terhune contributed to and advised at all phases of the process including design, data collection, data analyses, drafting of the paper and approval of final version.

Data Availability Statement
This study was pre-registered (osf.io/vc4fx) and the data are freely available (osf.io/hca6g). A preprint version of this article is available on medRxiv [10.31234/osf.io/nhb9q]
References

1. Stein MV HR, Wieder L, Terhune DB Responsiveness to direct verbal suggestions and dissociation predict symptoms attributed to environmental factors PsyArXiv. 2022.


