*Development and Psychopathology* (2024), 1–8
doi:10.1017/S0954579423001554

CAMBRIDGE UNIVERSITY PRESS

## Regular Article

# The role of environmental sensitivity in post-traumatic stress symptoms in Lebanese children and adolescents

Elie G. Karam[1,2,3], John Fayyad[1,2,3,†], Yuanyuan Huang[4], Dahlia Saab[1], Josleen Al Barathie[1] and Michael Pluess[4]

[1]Institute for Development, Research, Advocacy and Applied Care (IDRAAC), Beirut, Lebanon, [2]Department of Psychiatry and Clinical Psychology, University of Balamand Faculty of Medicine, Beirut, Lebanon, [3]Department of Psychiatry and Clinical Psychology, St George Hospital University Medical Center, Beirut, Lebanon and [4]Department of Biological and Experimental Psychology, School of Biological and Behavioural Sciences, Queen Mary University of London, Mile End Road, London, UK

**Abstract**

Children differ substantially in their sensitivity to the quality of their environment. Some are more sensitive and more likely to develop Post-Traumatic Stress Disorder (PTSD) in response to Childhood Adversities (CAs), but might also benefit more from Positive Home Experiences (PHE). The aim of this study is to investigate the role of Environmental Sensitivity (ES), CAs and PHEs in PTSD development in children and adolescents. Data was collected from $N = 2{,}569$ children/adolescents. PTSD symptoms, CAs, PHEs and ES were assessed with self-report measures. We found that higher ES and CAs emerged as risk factors for PTSD development whereas higher levels of PHEs protected against PTSD. ES moderated the effects of CAs ($\beta = 1.08$, $p < .001$) on PTSD symptoms in the total sample. This moderating effect was more pronounced in girls, suggesting that highly sensitive girls with high childhood adversities were more likely to have higher PTSD symptoms than girls with low levels of sensitivity ($\beta = 1.09$, $p < .001$). In conclusion, Environmental Sensitivity played an important role as a risk factor for PTSD and as a moderating factor that accentuated the main effects of childhood adversities, particularly in girls.

**Keywords:** childhood adversities; environmental sensitivity; positive home experiences; PTSD; trauma

(Received 8 April 2022; revised 17 November 2023; accepted 20 November 2023)

## Introduction

Childhood adversities (CAs) and other traumatic events have been found to significantly predict Post-Traumatic Stress Disorder (PTSD) in childhood and adolescence, whether they occur alone or in the form of polytraumatizition (Cloitre et al., 2009; Copeland et al., 2007). However, not all children who are exposed to early adversities develop PTSD or other mental disorders. Additional factors such as a positive family environment may buffer the negative effects of trauma and adversity in childhood. For example, parental support has been found to be protective against PTSD in war-exposed children (Thabet et al., 2009), and so was high siblingship warmth (Panter-Brick et al., 2014), and a positive family ambiance (Khamis, 2005). Moreover, children also differ in their vulnerability to PTSD due to individual traits with some being more at risk for the development of psychopathology than others. The most commonly used model for such individual differences has been the *Diathesis-Stress* model (Monroe & Simons, 1991; Zuckerman, 1999) according to which some people are more vulnerable to the negative effects of adversity than others due to some inherent vulnerability, such as personality traits or genetic factors. More recently, it has been suggested that some children may differ more generally in their sensitivity to environmental influences with some being more affected by both negative *and* positive experiences (Pluess & Boniwell, 2015). For example, according to the framework of *Differential Susceptibility* (Belsky & Pluess, 2009), the same children that are more 'vulnerable' to the negative effects of adversity also reap the most benefit from environmental support and enrichment due to their inherently heightened sensitivity to the quality of their environment. A large number of studies provide empirical evidence for such differences in *Environmental Sensitivity* (ES; Pluess & Boniwell, 2015) as a function of genetic, physiological, and psychological factors (for review, see Belsky & Pluess, 2009, 2013). While ES has a substantial genetic basis (Assary et al., 2021), it is equally shaped by environmental factors. Defined as a temperament trait which reflects the ability to perceive and process information about the environment (Pluess & Boniwell, 2015), ES can be measured reliably in children with a short questionnaire, the *Highly Sensitive Child* (HSC) scale (Pluess et al., 2018). The HSC scale is a 12-item self-report measure based on a longer adult version, the *Highly Sensitive Person* scale (HSP; Aron & Aron, 1997). The HSC and HSP scales have been designed to capture *Sensory Processing Sensitivity* (Aron & Aron, 1997), a temperament trait characterized by heightened sensory sensitivity, depth of processing, emotional and physiological reactivity as well as overstimulation (Aron et al., 2012). According to theory, such Sensory Processing Sensitivity is one of the hypothesized factors underlying individual differences in Environmental Sensitivity (Pluess & Boniwell, 2015). Several studies provide evidence that children that score high on the HSC

**Corresponding author:** Elie G. Karam; Email: egkaram@idraac.org
[†]Deceased.

**Cite this article:** Karam, E. G., Fayyad, J., Huang, Y., Saab, D., Al Barathie, J., & Pluess, M. (2024). The role of environmental sensitivity in post-traumatic stress symptoms in Lebanese children and adolescents. *Development and Psychopathology*, 1–8, https://doi.org/10.1017/S0954579423001554

scale, are more affected by negative experiences, such as war exposure and childhood adversities (Karam et al., 2019), but also benefit more from positive exposures, including school-based psychological programs (Nocentini et al., 2018; Pluess & Boniwell, 2015) and caring and supportive parenting (Slagt et al., 2018).

In this paper, we investigate the role of ES, measured with the Arabic version of the HSC scale, in the development of PTSD related to CAs and Positive Home Experiences (PHE) in a large sample of Lebanese children and adolescents. Besides considering main effects of sensitivity, CAs and PHEs, we particularly focus on the hypothesized moderating effects of ES. Importantly, we test the moderating effects of ES in the total sample as well as separately for boys and girls based on some suggestive evidence that the moderating effects of sensitivity has been found to be more pronounced in boys, despite girls scoring higher on the HSC scale (Nocentini et al., 2018). The interplay between characteristics of the individual and adversity is known to be important in the genesis of trauma related disorders such as PTSD. ES appears to be one important agent of these interactions. Indeed, we recently published a manuscript on 549 Syrian refugee children in Lebanon who had been exposed to war in their home country, where we assessed the association of ES as defined above, as well as CAs with PTSD. The interplay between CAs and ES had a significant effect on the association of war exposure with PTSD. This association was the strongest in highly sensitive children with lower levels of adversities and was not as pronounced in sensitive children that experienced higher levels of adversities (Karam et al., 2019). In the present study, we focus on a sample of 2,569 Lebanese children and adolescents who have never been directly exposed to war, in order to investigate the interplay between ES, CAs, and PHEs on the genesis of PTSD in the absence of recent war exposure. We specifically focus on Lebanese youth given that our previous paper (Karam et al., 2019) investigated the moderating role of sensitivity in Syrian refugee children living in Lebanon who have a history of war exposure. Lebanese pupils, on the other hand, have not been exposed to war and are therefore more comparable to the general population that have not been subjected to trauma.

Informed by the framework of *Environmental Sensitivity* (Pluess & Boniwell, 2015), we expected that more sensitive children would have higher PTSD scores when having been exposed to more CAs but also lower PTSD scores when growing up in a more positive home environment (PHE). Children with lower sensitivity, on the other hand, would be less affected by either CAs or PHEs.

## Method

### Sample

The sample consisted of pupils from Lebanese public schools with a school population of 100 students or more selected by the research team as a target for a classroom intervention to alleviate the burden of mental disorders (not covered in this paper). Schools were recommended by the Ministry of Social Affairs and the Ministry of Education and Higher Education of Lebanon given the limited psychosocial support provided to them by Non-Governmental Organizations (NGOs). It is worth noting that Lebanese children (defined as holders of a Lebanese ID) were prioritized in this analysis to exclude the experience of any direct exposure to war. All children and adolescents in grades 4–7 within these schools were enrolled. We focused on grades 4 – 7 in order to achieve an age range from 8 to 17 years (limiting the age to below 18 but still mature enough to understand the questionnaires). Following the recruitment visits to the schools' principals, the participation rates were as follows: 10/14 schools for Aley, 5/8 for Jounieh, 4/7 for the Chiyah district (1 school from this area was later excluded due to poor supervision of data collection by the designated field worker), 6/9 for Sidon, and 7/12 for the Metn region. The reasons for refusal were administrative in nature, such as the school prior commitment to other projects.

The number of Lebanese pupils enrolled in the study was 2,569 from a total of 31 schools with 18.5% from Grade 4,24.6% from Grade 5,28.5% from Grade 6, and 28.4% from Grade 7.34 participants were excluded because they were younger than 8 years or older than 17 years. Less than 1% of the data were missing and Little's MCAR test (Little 1988) indicated that the data were missing completely at random (MCAR), $\chi^2$ (15, $N = 2569$) = 11.32, $p = .73$. Hence, multiple imputation ($m = 5$) was applied to handle the missing data (Graham, 2009). Finally, 123 participants with extreme values (± 3 SD from the mean) on key variables were identified as outliers and excluded from the dataset in order to reduce bias caused by unreliable data. According to comparisons between included and excluded participants, there were no significant gender, $\chi^2$ (1, 2508) = 1.408, $p = .235$ or age differences, $F$ (1, 2507) = .871, $p = .351$. The final sample included 2,412 participants.

### Procedures

Staff from the *Institute for Development, Research, Advocacy and Applied Care* (IDRAAC) trained a total of 48 school teachers and 12 field workers on delivering and collecting the self-completed questionnaires administered to the pupils. To ensure the data collection process was thorough, we assigned field workers to individual classrooms to assist and monitor teachers during the data collection phase which took place over two classroom sessions. Any problems that were encountered on the field were directly reported to the project manager by the field workers. Ethical approval was obtained from the Institutional Review Board at the Faculty of Medicine of the University of Balamand which is registered with the U.S. Office of Human Research Protections in the Department of Health and Human Services. Consent was obtained from parents and verbal assent was taken from students.

### Measures

Post-Traumatic Stress Disorder (PTSD) symptoms were assessed using the PTSD Reaction Index (PTSD-RI) for DSM IV. This scale includes a total of 21 items rated on a scale ranging from 0 to 4 (Pynoos et al.,1998). The PTSD-RI has been used extensively internationally and in various Arab populations including children and adolescents in Gaza and Kuwait (Thabet & Vostanis, 2004; Miller et al.,1999; Nader et al., 1993). Cronbach's alpha for internal consistency of items in the current sample was good with $\alpha = .91$.

CAs were measured cumulatively and included 29 items based on the ISPCAN Child Abuse Screening Tool (ICAST; 17 items; Runyan et al, 2009), as well as a list of adversities (10 items) derived from focus group discussions with mothers based on their local experiences and reports of the most common adversities encountered by Lebanese children (Karam et al, 2016), and two additional items related to childhood neglect inspired by the Composite International Diagnostic Interview (Kessler & Ustun, 2004), a well-established instrument used extensively and internationally in epidemiologic studies (see supplementary material for a

https://doi.org/10.1017/S0954579423001554 Published online by Cambridge University Press

list of all included items). The CAs items were rated on a scale ranging from 0 = "Never/Rarely", 1 = "Sometimes", to 2 = "Often/Always". ICAST adversities were originally collected with the following responses: 0 = "Never", 1 = "Sometimes in the past year", 2 = "Always in the past year" (score of 2), or "Not in the past year, but happened in the past". For respondents who chose the option "not in the past year but happened in the past" for any item, a score between 0 and 2 was imputed based on the average responses to other ICAST items that occurred during the past year. This average was calculated by dividing the total sum of their scores on items that happened in the past year over the number of items that did happen to them in the past year (Karam et al., 2019). Questions on sexual abuse were excluded from our tool at the insistence of school authorities. The most common CA events in this sample were: *"parents screamed at the child in a loud voice or violent manner"* (34.11%), *"the child was hit by his/her siblings"* (26.61%), *"a family member suffering from a chronic medical illness"* (24.25%) and *"parents are irritable and often get easily angry for many years"* (23.77%). The cumulative score was recoded into categories given the skewed distribution and lack of linearity between variables. Participants scoring 0 ($n = 747$) were categorized as "No childhood adversity", those scoring between 1 and 3 ($n = 838$) as "Medium childhood adversity", and individuals scoring 4 or more ($n = 800$) as "High childhood adversity". These were coded as 0, 1 and 2, respectively. Two dummy variables (CAs_high and CAs_medium) were generated based on this categorization and applied to the regression model.

A cumulative measure of Positive Home Experiences (PHE) was developed as part of this study and included nine items that capture positive experiences of the child at home, each rated on a scale ranging from 1 = "Never", 2 = "Rarely", 3 = "Sometimes", 4 = "A lot" to 5 = "Always" (see supplementary material for a list featuring all items). Six out of the nine items ("*my parents spend enough time to listen and talk to me", "my siblings and I help each other in difficult times", "my parents provide me with security and safety", "I have leisure activities other than watching TV", "my parents are present with me during homework", and "I don't lack help at home in my studies*") were from a new scale titled "psychosocial stressors, coping and war exposure questionnaire". This scale was developed based on a series of focus group discussions which were held with children, adolescents, mothers, teachers and school principals to delineate the types of events. This scale has been used in a previous study (Fayyad et al., 2017). In addition, three items ("*my parents are present during lunch/dinner time", "my parents are present with me during playtime", and "my parents are present with me during bedtime*") were added to capture time children spent with their parents. In the current analysis, we bracketed the categories into three: 0 = "Never/Rarely", 1 = "Sometimes", or 2 = "Often/Always", yielding a PHE total score that could range from 0 to 18. The internal consistency of the 9 PHE items was acceptable with $\alpha = .68$. The most common PHE events in this sample were *"parents provide the child with security and safety"* (91.8%), *"parents are present during lunch/dinner time"* (89.77%), *"the child does not lack help at home in his/her studies"* (86.73%), and *"the child has leisure activities other than watching TV"* (84.54%) (see Supplementary Information for further details). Cumulative scores were recoded into categorical variables due to the skewed distribution and low linearity. Participants scoring between 0 and 10 ($n = 733$) were categorized as "Low positive home experience", those scoring between 10 and 14 ($n = 973$) as "Medium home experiences", and individuals scoring 14 or more ($n = 679$) as "High positive home experiences". These were coded as 0, 1 and 2, respectively. Similarly to CAs, two dummy variables (PHE_high and PHE_medium) were generated based on the categorization of the PHE variable and applied to the regression model.

Environmental Sensitivity was measured with the *Highly Sensitive Child* scale (HSC) (Pluess et al, 2018). The HSC includes a total of 12 items, each rated on a scale ranging from 1 to 7 (1 = do not agree, 7 = totally agree). The scale includes items such as "I notice when small things have changed in my environment", "Loud noises make me feel uncomfortable"; and "I find it unpleasant to have a lot going on at once". The HSC reflects a bifactor structure with one general sensitivity factor and three individual factors. The individual factors include *Ease of Excitation*, which reflects being easily overwhelmed, *Low Sensory Threshold*, which captures unpleasant sensory arousal, and *Aesthetic Sensitivity*, which measures sensitivity to positive aspects of the environment. In this analysis, we used the HSC mean score (range: from 1 to 7). The HSC scale was translated into Arabic and back-translated into English, followed by focus group discussions and reviewed by an expert panel from IDRAAC to resolve any disagreements. The questionnaire was then delivered to a community group of children and adolescents, to get their feedback about the wording and the meaning of the questions. The final form was agreed on by the expert panel. Test-retest reliability across three weeks was assessed in a sample of 50 Lebanese pupils in grade 6 and was acceptable with an intra-class correlation coefficient of $r = .66$ ($p < .01$). Although internal consistency of the original scale in UK-based samples was generally good with $\alpha = .70$-82 (Pluess et al., 2018), it was slightly lower in this sample with $\alpha = .61$. The three-factor structure of the original scale was confirmed in this sample with Confirmatory Factor (CFA). The CFA model yielded a good fit (CFI = .94, RMSEA = .03), with factor loadings of the items ranging from.14 to .65 in the CFA model.

### Statistical analysis

After investigating descriptive data, we conducted bivariate correlations between ES, PHEs, and CAs. We then included the different factors that are associated with PTSD (gender, age, PHE, CA, and ES) in a multiple regression model to test main effects controlling for all other factors. As a next step we rerun this regression model with inclusion of interaction terms between ES and PHE as well ES and CAs in the total sample in two separate model (a combined model is provided in supplementary material). These interactions were then tested separately for boys and girls. Significant interactions were further examined in follow-up analyses with simples slopes for extreme groups (± 1 SD from the mean). The level of significance was set at $p = .05$ for all tests. Analyses were conducted using SPSS version 20.

## Results

### Sample characteristics on outcome and exposures

The mean age of the final sample was 12.40 ± 1.68 years (range: 8–17 years), with 51.8% females. The distributions of both environmental sensitivity and PTSD were not normal, but the value of skewness and kurtosis were acceptable (greater than −2 and less than 2). The mean of ES was 5.25 ($SD = .82$). The ES means for girls and boys were 5.32 ($SD = .86$) and 5.17 ($SD = .77$), respectively. Finally, the mean PTSD score was 7.92 ($SD = 8.82$), with .9% of the sample being above the

https://doi.org/10.1017/S0954579423001554 Published online by Cambridge University Press

clinical cutoff score of 37 on the PTSD-RI. (See Table S1 for more information on descriptives).

### Bivariate correlations

CAs and PHE were minimally but not significantly correlated with ES ($r = -.004$ $p = .84$ and $r = .029$, $p = .16$, respectively for CAs and ES, and PHE and ES). CAs and PHE were negatively correlated, although weakly so ($r = -.331$, $p < .001$; see Table S2).

### Main effects

The bivariate analysis showed that CA and ES were significant risk factors for PTSD development and PHE was protective (see Table S2). In the hierarchical regression model, all the concerned variables were significantly associated with PTSD symptoms (see Table 1). We then investigated interactions of CAs and PHEs with ES in their relation to PTSD scores, in the total sample as well as for males and females separately, adjusting for all other variables in the model as shown in Table 1.

### Moderating effects (PHE)

The interaction between PHE and ES was not significant in the total sample, nor in the male or female subsamples (see Table 1). However, further exploratory inspection of the data with simple slopes of extreme groups suggested that there was a slight but non-significant trend with highly sensitive children being more negatively affected by low PHE but not benefitting more from high PHE.

### Moderating effects (CAs)

The interaction between CAs and ES was significant in the total as well as the female sample but not in the male sample (total sample: $B = .11$, $p = .02$; boys: $B = .11$, $p = .11$; girls: $B = .13$, $p = .04$) (See Table 1). A follow-up simple slope analysis showed that for children with high sensitivity the association between CA and PTSD was stronger ($\beta = 1.08$, $p < .001$) than for children with medium ($\beta = .97, p < .001$) or low sensitivity ($\beta = .85, p < .001$. (see Figure 1). This interaction was more pronounced in girls with highly sensitive girls having higher PTSD scores when experiencing CA ($\beta = 1.09$, $p < .001$) compared to medium ($\beta = .96$, $p < .001$) and low sensitive girls ($\beta = .83$, $p < .001$) (see Figure 2). Although the interaction for males was not significant the simple slopes pattern that emerged was similar (see Figure S1).

### Sensitivity analysis

In addition to the separate models, we also tested a combined model that included all interaction terms (both CA and PHE). Findings remained similar with only the interaction between CA and ES being significant ($B = .11$, $p = .02$; see Table S3).

## Discussion

The aim of this study was to investigate the role of Environmental Sensitivity (ES), a common temperament trait assessed with the *Highly Sensitive Child* scale (Pluess et al., 2018), in the development of PTSD symptoms in a large sample of Lebanese children and adolescents. More specifically, we investigated the main effects of ES on PTSD as well as whether ES moderates the effects of negative and positive environmental factors on PTSD symptoms with moderating effects expected to be higher among boys. Consistent with our hypotheses, higher ES was associated with higher PTSD scores. In addition, ES moderated the negative effects of CAs, but not the positive effects of PHEs, in association with PTSD symptoms. Furthermore, the moderating effects were more pronounced in girls not supporting our original hypothesis.

Concerning main effects, CAs were prominently associated with PTSD, with cumulative effects consistent with studies on polytraumatization (Cloitre et al, 2009; Copeland et al., 2007; Gustafsson et al., 2009). Consistent with our hypothesis, we did find that PHEs were protective against developing PTSD. In addition, ES emerged as an independent risk factor associated with PTSD, with higher levels of ES associated with higher PTSD scores. This is consistent with our previous work on ES in the development of PTSD symptoms among war-exposed Syrian refugee children (Karam et al., 2019). Our findings suggest that ES represents an important risk factor for the development of PTSD in children and adolescents, whether they have a history of war exposure or not.

Importantly, ES emerged as a moderator of the effects of negative experiences (CAs) in this sample. However, the interaction between ES and positive experiences was not significant. Previous studies on children have shown that sensitive children are more affected by what they experience. For example, sensitive girls in the UK have been found to benefit more from a school-based resilience promoting intervention (Pluess & Boniwell, 2015), sensitive boys in Italy responded more strongly to the positive effects of a school-based anti-bullying intervention (Nocentini et al., 2018), and Dutch children that were rated as more sensitive by their parents were more affected by both changes in negative and positive parenting practices compared to less sensitive children (Slagt et al., 2018). In the present study, ES moderated the effects of adverse but not the positive effects of protective factors in association with PTSD. The interaction between ES and CAs was consistent with our hypothesis that more sensitive children would be more negatively affected by an adverse experience (i.e., reflecting a *Diathesis-Stress* pattern). These findings are, at least partially, consistent with theories of *Environmental Sensitivity* (Pluess & Boniwell, 2015). Our analyses could not prove that ES moderates the positive effects of positive home experiences even though there was a clear trend in the data suggesting that highly sensitive children are more negatively affected by the absence of positive experiences (see supplementary material). It is conceivable that the applied measure of PHE was too broad and unspecific in capturing the specific elements that sensitive children might be particularly sensitive to. Longitudinal designs and stronger measures of environmental quality will be necessary to disentangle the exact relationship between ES, negative and positive environmental factors, and PTSD symptoms.

A further finding of this study is that boys and girls differed in their self-reported ES. Consistent with many other studies that used validated sensitivity measures (Lionetti et al., 2019, 2018, Pluess et al., 2018), girls tended to report higher sensitivity than boys. However, the moderating effects between ES and adverse environmental factors was found to be stronger in girls compared to boys. Importantly, this differs from a previous study using the HSC scale (Nocentini et al., 2018) and a study investigating genetic markers of sensitivity (e.g., Belsky & Beaver, 2011), where males emerged as being more affected by environmental quality compared to girls. Hence, it is not clear whether there are stable gender differences in the sensitivity to environmental influences. What is consistent with the literature, is that girls are at higher risk for PTSD than boys, due to the common comorbidity with depression and anxiety in girls. More work is necessary to investigate the existence and nature of gender differences in ES.

https://doi.org/10.1017/S0954579423001554 Published online by Cambridge University Press

**Table 1.** Results from models testing the main and moderating effects of environmental sensitivity between CA and PHE on PTSD in Lebanese children and adolescents

| | PTSD(ALL) | | | | | | PTSD(FEMALES) | | | | | | PTSD(MALES) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Predictor | *B* | 95% CI | *t* | *p* | $R^2$ | $\Delta R2$ | *B* | 95% CI | *t* | *p* | $R^2$ | $\Delta R^2$ | *B* | 95% CI | *t* | *p* | $R^2$ | $\Delta R^2$ |
| Models assessing buffering role of PHE Total sample: $F$ (7,2404) = 11.519, $p < .001$. Female: $F$ (6, 1242) = 10.723, $p < .001$, Male: $F$ (6, 1156) = 7.738, $p < .001$. | | | | | | | | | | | | | | | | | | |
| **Step 1** | | | | | | | | | | | | | | | | | | |
| Gender | .079 | [−.001, .160] | 1.947 | 0.051 | .002 | .002 | | | | | | | | | | | | |
| Age | .007 | [−.017, .031] | .559 | 0.576 | | | .071*** | [.037, .104] | 4.155 | <.001 | .013 | .013*** | −.069*** | [−.103, −.036] | −4.068 | <.001 | .014 | .014*** |
| **Step 2** | | | | | | | | | | | | | | | | | | |
| PHE_medium | −.176*** | [−.271, −.081] | −3.626 | <.001 | .022 | .021*** | −.169* | [−.311, −.027] | −2.326 | .020 | .036 | .022*** | −.146* | [−.271, −.020] | −2.271 | .023 | .030 | .017*** |
| PHE_high | −.372*** | [−.475, −.268] | −7.037 | <.001 | | | −.405*** | [−.554, −.256] | −5.332 | <.001 | | | −.312*** | [−.455, −.169] | −4.276 | <.001 | | |
| **Step 3** | | | | | | | | | | | | | | | | | | |
| ES | .100*** | [.060, .140] | 4.890 | <.001 | .032 | .010*** | .109*** | [.053, .164] | 3.844 | <.001 | .046 | .011*** | .075* | [.017, .133] | 2.523 | .012 | .036 | .006** |
| **Step 4** | | | | | | | | | | | | | | | | | | |
| **ES** × PHE_medium | −.033 | [−.128, .062] | −.689 | 0.491 | .032 | <.001 | .015 | [−.121, .151] | .221 | .825 | .048 | .001 | −.108 | [−.241, .026] | −1.583 | .113 | .039 | .003 |
| **ES** × PHE_ high | −.055 | [−.156, .045] | −1.080 | 0.280 | | | −.068 | [−.206, .071] | −.959 | .338 | | | −.029 | [−.182, .123] | −.377 | .706 | | |
| Models assessing accelerating role of CA Total sample: $F$ (7,2399) = 70.065, $p < .001$). Female: $F$ (6,1241) = 42.673, $p < .001$, Male: $F$ (6,1152) = 42.426, $p < .001$. | | | | | | | | | | | | | | | | | | |
| **Step 1** | | | | | | | | | | | | | | | | | | |
| Gender | .079 | [−.001, .159] | 1.947 | .052 | .002 | .002 | | | | | | | | | | | | |
| Age | .007 | [−.017, .030] | .546 | .585 | | | .071*** | [.037, .104] | 4.136 | <.001 | .013 | .013*** | −.069*** | [−.103, −.036] | −4.070 | <.001 | .014 | .014*** |
| **Step 2** | | | | | | | | | | | | | | | | | | |
| CAs_medium | .324*** | [.234, .415] | 7.038 | <.001 | .160 | .159*** | .321*** | [.194, .448] | 4.939 | <.001 | .159 | .145*** | .313*** | [.186, .440] | 4.826 | <.001 | .175 | .161*** |
| CAs_high | .972*** | [.880, 1.063] | 20.804 | <.001 | | | .969*** | [.837, 1.100] | 14.439 | <.001 | | | .937*** | [.810, 1.065] | 14.411 | <.001 | | |
| **Step 3** | | | | | | | | | | | | | | | | | | |
| ES | .084*** | [.047, .121] | 4.404 | <.001 | .167 | .007*** | .093*** | [.041, .145] | 3.524 | <.001 | .167 | .008*** | .062* | [.008, .116] | 2.269 | .023 | .179 | .004* |
| **Step 4** | | | | | | | | | | | | | | | | | | |
| **ES** × CAs_medium | .006 | [−.082, .095] | .137 | .891 | .170 | .003* | −.027 | [−.146, .093] | −.441 | .659 | .171 | .004* | .060 | [−.075, .195] | .866 | .386 | .181 | .002 |
| **ES** × CAs_ high | .112* | [.022, .203] | 2.439 | .015 | | | .132* | [.007, .258] | 2.071 | .038 | | | .110 | [−.025, .245] | 1.598 | .110 | | |

*Note*. The displayed coefficients of the variables at all steps represent the values before inclusion of variables of the next step. PHE = positive home experiences; ES = environmental sensitivity; CAs = childhoodadversities. *$p < .05$. **$p < .01$. ***$p < .001$.

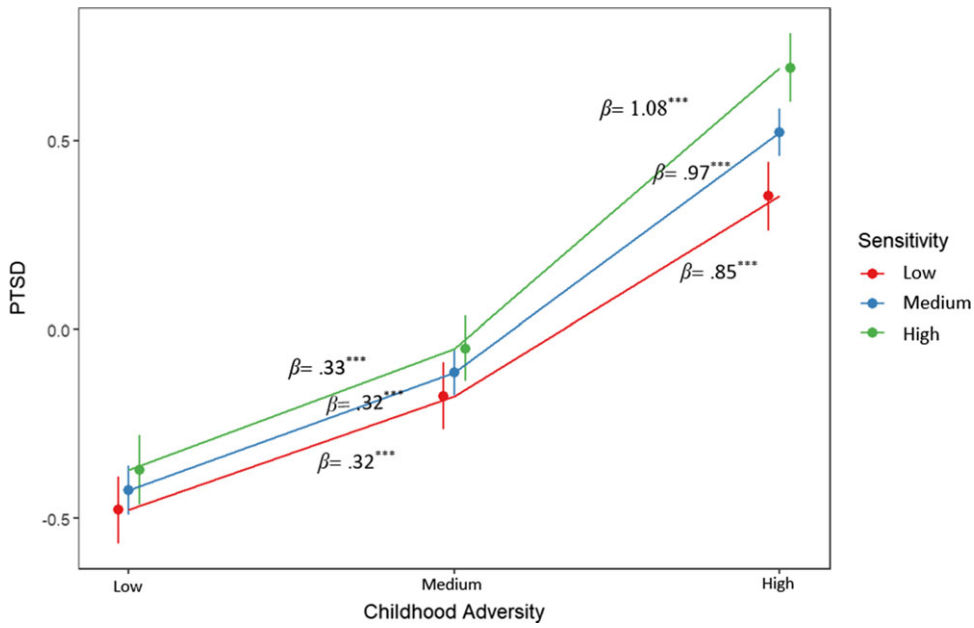


**Figure 1.** Moderating effect of environmental sensitivity on the relation between CAs and PTSD in the total sample. *Note*. The figure shows simple slopes between childhood adversity and PTSD for extreme groups of environmental sensitivity (Mean ± 1SD). *$p < .05$. **$p < .01$. ***$p < .001$.

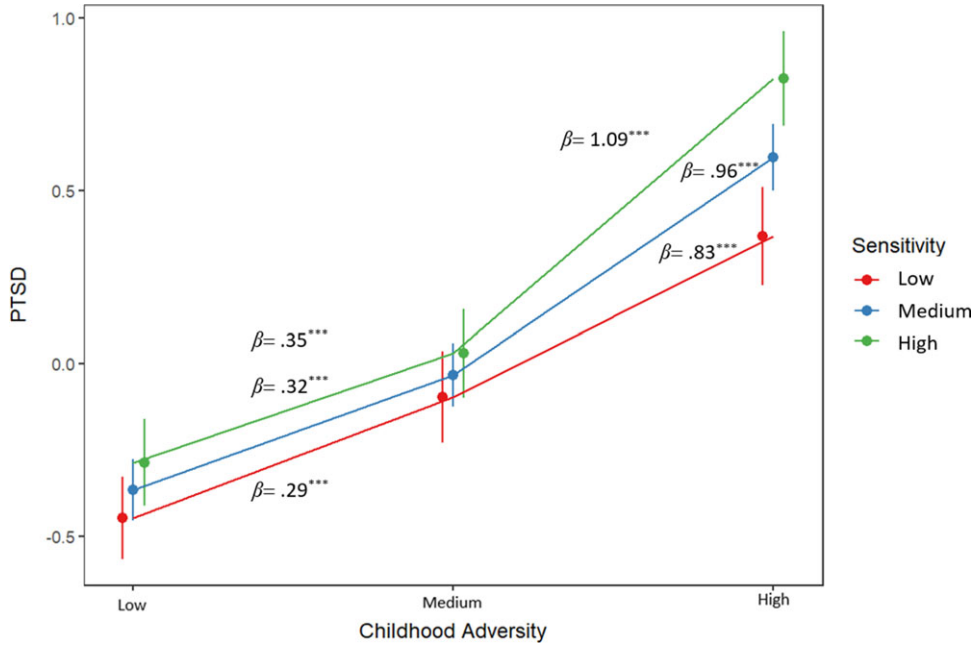


**Figure 2.** Moderating effect of environmental sensitivity on the relation between CAs and PTSD for females. *Note*. The figure shows simple slopes for females between childhood adversity and PTSD for extreme groups of environmental sensitivity (Mean ± 1 SD). *$p < .05$. **$p < .01$. ***$p < .001$.

Despite the large sample size, our study has a number of limitations. First, there are many other factors that have important positive effects on mental health in general and PTSD in particular including social support outside the family, and secure attachments with non-parental figures, which were not available in this study. Similarly, there are also other negative factors than childhood adversities that were not assessed in this study (e.g., traumatic experiences). Secondly, the measures used to assess CA and PHE reflect cumulative scales and, consequently, were skewed and lacked linearity. We addressed this issue by categorizing these two scales which overcomes the linearity problem but also led to a loss of information. Future studies should replicate our findings with measures that perform better. Thirdly, our sample, though large, is not representative of the Lebanese population of children and adolescents. Fourthly, all measures are based on self-report. Fifthly, the Arabic translation of the HSC scale has a somewhat lower internal consistency than the original English scale which may suggest that the translated items may perform slightly different in the context of Lebanese youth. Finally, we applied a cross-sectional design which does not allow testing for causal relationships and changes over time. Nonetheless, this study is valuable and unique in highlighting the important effects of PHEs in a large population of children and adolescents in the prediction of PTSD symptoms, in addition to exposure to the established and frequently assessed array of CAs. While the role of positive home environment is well established, previous evidence on protective effects of parental support in reducing PTSD often focused on samples of children who were affected by war (Panter-Brick et al., 2014; Punamaki et al., 2001; Thabet et al., 2009). Our findings confirm these findings in a non-war exposed and non-clinical

https://doi.org/10.1017/S0954579423001554 Published online by Cambridge University Press

sample. Lastly our findings on the role of ES are of special importance since, if confirmed in other settings and cultures, it could constitute a valuable and useful tool for our understanding of the role of negative and positive effects of life events on PTSD and other disorders. For example, by elucidating why and how children differ in their response to both negative and positive life experiences. Future research should aim to replicate these findings in different cultures with more established measures as well as in longitudinal and experimental study designs. Furthermore, it will be important to further investigate the detected gender differences in sensitivity to the high adversity and low support, as found in the current study.

In conclusion, we found that the temperament trait of *Environmental Sensitivity*, measured with a short questionnaire, was associated with higher PTSD symptoms in a large sample of Lebanese children and adolescents. Besides the significant main effect on PTSD, sensitivity moderated the negative impact of childhood adversity (but not the positive effects of a supportive home environment). Sensitive children were more strongly affected by negative effects on PTSD development. Importantly, these effects were more pronounced in girls. Our findings suggest that future studies on the etiology of PTSD in children should consider the trait of Environmental Sensitivity in order to advance our understanding of the development of PTSD.

**Supplementary material.** The supplementary material for this article can be found at https://doi.org/10.1017/S0954579423001554.

**Acknowledgements.** The authors would like to thank Dr. Aimee N. Karam, Ms. Caroline Cordahi-Tabet and Ms. Youmna Cassir-Haddad who contributed to discussions and review of the translation of the HSC into Arabic. The authors would like to thank also Ms. Claudia Farhat for her contribution to earlier analysis work related to this manuscript. Yuanyuan Huang is funded by the China Scholarship Council from the Ministry of Education of P.R. China.

**Funding statement.** This work was supported partially by the USA Department of State, the Bureau of Population, Refugees and Migration/UNFPA under grant [number LBN3U7207]; and US Embassy in Lebanon under grant [number S-LE200-13-GR-028] and private donations to IDRAAC.

**Competing interests.** None.

## References

**Aron, E. N., & Aron, A.** (1997). Sensory-processing sensitivity and its relation to introversion and emotionality. *Journal of Personality and Social Psychology*, *73*(2), 345–368. https://doi.org/10.1037//0022-3514.73.2.345

**Aron, E. N., Aron, A., & Jagiellowicz, J.** (2012). Sensory processing sensitivity: A review in the light of the evolution of biological responsivity. *Personality and Social Psychology Review*, *16*(3), 262–282. https://doi.org/10.1177/1088868311434213

**Assary, E., Zavos, H. M. S., Krapohl, E., Keers, R., & Pluess, M.** (2021). Genetic architecture of environmental sensitivity reflects multiple heritable components: A twin study with adolescents. *Molecular Psychiatry*, *26*(9), 4896–4904. https://doi.org/10.1038/s41380-020-0783-8

**Belsky, J., & Beaver, K. M.** (2011). Cumulative-genetic plasticity, parenting and adolescent self-regulation. *Journal of Child Psychology and Psychiatry*, *52*(5), 619–626. https://doi.org/10.1111/j.1469-7610.2010.02327.x

**Belsky, J., & Pluess, M.** (2009). Beyond diathesis stress: Differential susceptibility to environmental influences. *Psychological Bulletin*, *135*(6), 885–908. https://doi.org/10.1037/a0017376

**Belsky, J., & Pluess, M.** (2013). Beyond risk, resilience, and dysregulation: Phenotypic plasticity and human development. *Development and Psychopathology*, *25*(4pt2), 1243–1261. https://doi.org/10.1017/S095457941300059X

**Cloitre, M., Stolbach, B. C., Herman, J. L., van der Kolk, B., Pynoos, R., Wang, J., & Petkova, E.** (2009). A developmental approach to complex PTSD: Childhood and adult cumulative trauma as predictors of symptom complexity. *Journal of Traumatic Stress*, *22*(5), 399–408. https://doi.org/10.1002/jts.20444

**Copeland, W. E., Keeler, G., Angold, A., & Costello, E. J.** (2007). Traumatic events and posttraumatic stress in childhood. *Archives of General Psychiatry*, *64*(5), 577–584. https://doi.org/10.1001/archpsyc.64.5.577

**Fayyad, J., Cordahi-Tabet, C., Yeretzian, J., Salamoun, M., Najm, C., & Karam, E. G.** (2017). Resilience-promoting factors in war-exposed adolescents: An epidemiologic study. *European Child & Adolescent Psychiatry*, *26*(2), 191–200. https://doi.org/10.1007/s00787-016-0871-0

**Graham, J. W.** (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, *60*(1), 549–576. https://doi.org/10.1146/annurev.psych.58.110405.085530

**Gustafsson, P. E., Nilsson, D., & Svedin, C. G.** (2009). Polytraumatization and psychological symptoms in children and adolescents. *European Child & Adolescent Psychiatry*, *18*(5), 274–283. https://doi.org/10.1007/s00787-008-0728-2

**Karam, E. G., Fayyad, J. A., Farhat, C., Itani, L., Mneimneh, Z. N., Karam, A. N., & Karam, G. E.** (2016). War and the mental health of civilians: What did we learn so far from Lebanon?. In G. Christodoulou (Eds.), *Disasters: Mental health context and responses* (pp. 125–150). Cambridge Scholars Publishing.

**Karam, E. G., Fayyad, J. A., Farhat, C., Pluess, M., Haddad, Y. C., Tabet, C. C., Farah, L., & Kessler, R. C.** (2019). Role of childhood adversities and environmental sensitivity in the development of post-traumatic stress disorder in war-exposed Syrian refugee children and adolescents. *The British Journal of Psychiatry*, *214*(6), 354–360. https://doi.org/10.1192/bjp.2018.272

**Kessler, R. C., Üstün, T. B.** (2004). The World Mental Health (WMH) survey initiative version of the World Health Organization (WHO) composite international diagnostic interview (CIDI). *International Journal of Methods in Psychiatric Research*, *13*(2), 93–121. https://doi.org/10.1002/mpr.168

**Khamis, V.** (2005). Post-traumatic stress disorder among school age Palestinian children. *Child Abuse & Neglect*, *29*(1), 81–95. https://doi.org/10.1016/j.chiabu.2004.06.013

**Lionetti, F., Aron, A., Aron, E. N., Burns, G. L., Jagiellowicz, J., & Pluess, M.** (2018). Dandelions, tulips and orchids: Evidence for the existence of low-sensitive, medium-sensitive and high-sensitive individuals. *Translational Psychiatry*, *8*(1), 24. https://doi.org/10.1038/s41398-017-0090-6

**Lionetti, F., Aron, E. N., Aron, A., Klein, D. N., & Pluess, M.** (2019). Observer-rated environmental sensitivity moderates children's response to parenting quality in early childhood. *Developmental Psychology*, *55*(11), 2389–2402. https://doi.org/10.1037/dev0000795

**Little, R. J.** (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American statistical Association*, 1198–1202.

**Miller, T., El-Masri, M., Allodt, F., Qouta, S.** (1999). II: Emotional and behavioural problems and trauma exposure of school-age Palestinian children in Gaza: Some preliminary findings. *Medicine, Conflict and Survival*, *15*(4), 368–393. https://doi.org/10.1080/13623699908409478

**Monroe, S. M., & Simons, A. D.** (1991). Diathesis-stress theories in the context of life stress research: Implications for the depressive disorders. *Psychological Bulletin*, *110*(3), 406–425. https://doi.org/10.1037/0033-2909.110.3.406

**Nader, K. O., Pynoos, R. S., Fairbanks, L. A., Al-Ajeel, M., Al-Asfour, A.** (1993). A preliminary study of PTSD and grief among the children of Kuwait following the Gulf crisis. *British Journal of Clinical Psychology*, *32*(4), 407–416. https://doi.org/10.1111/j.2044-8260.1993.tb01075.x

**Nocentini, A., Menesini, E., & Pluess, M.** (2018). The personality trait of environmental sensitivity predicts children's positive response to school-based antibullying intervention. *Clinical Psychological Science*, *6*(6), 848–859. https://doi.org/10.1177/2167702618782194

**Panter-Brick, C., Grimon, M. P., & Eggerman, M.** (2014). Caregiver—child mental health: A prospective study in conflict and refugee settings. *Journal of Child Psychology and Psychiatry*, *55*(4), 313–327. https://doi.org/10.1111/jcpp.12167

**Pluess, M., Assary, E., Lionetti, F., Lester, K. J., Krapohl, E., Aron, E. N., & Aron, A.** (2018). Environmental sensitivity in children: Development of the highly sensitive child scale and identification of sensitivity groups. *Developmental Psychology*, *54*(1), 51–70. https://doi.org/10.1037/dev0000406

**Pluess, M., & Boniwell, I.** (2015). Sensory-processing sensitivity predicts treatment response to a school-based depression prevention program: Evidence of vantage sensitivity. *Personality and Individual Differences*, *82*, 40–45. https://doi.org/10.1016/j.paid.2015.03.011

**Punamäki, R.-L., Qouta, S., El-Sarraj, E.** (2001). Resiliency factors predicting psychological adjustment after political violence among Palestinian children. *International Journal of Behavioral Development*, *25*(3), 256–267.

**Runyan, D. K., Dunne, M. P., Zolotor, A. J., Madrid, B., Jain, D., Gerbaka, B., Menick, D. M., Andreva-Miller, I., Kasim, M. S., Choo, W. Y., Isaeva, O., Macfarlane, B., Ramirez, C., Volkova, E., & Youssef, R. M.** (2009). The development and piloting of the ISPCAN child abuse screening tool—parent version (ICAST-P). *Child Abuse & Neglect*, *33*(11), 826–832. https://doi.org/10.1016/j.chiabu.2009.09.006

**Slagt, M., Dubas, J. S., van Aken, M. A. G., Ellis, B. J., & Deković, M.** (2018). Sensory processing sensitivity as a marker of differential susceptibility to parenting. *Developmental Psychology*, *54*(3), 543–558. https://doi.org/10.1037/dev0000431

**Thabet, A. A., Ibraheem, A. N., Shivram, R., Winter, E. A., & Vostanis, P.** (2009). Parenting support and PTSD in children of a war zone. *International Journal of Social Psychiatry*, *55*(3), 226–237.

**Thabet, A. A. M., Abed, Y., Vostanis, P.** (2004). Comorbidity of PTSD and depression among refugee children during war conflict. *Journal of Child Psychology and Psychiatry*, *45*(3), 533–542. https://doi.org/10.1111/j.1469-7610.2004.00243.x

**Zuckerman M.** (1999). *Vulnerability to psychopathology: A biosocial model*. American Psychological Association.

https://doi.org/10.1017/S0954579423001554 Published online by Cambridge University Press