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Posttraumatic stress symptoms in people exposed to the 2017 earthquakes in Mexico

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A B S T R A C T

This is the first study to produce a reliable valid measure of the symptoms of Posttraumatic Stress Disorders (PTSD) in Mexico, which has a high incidence of disasters, and has not had a measurement of PTSD frequency in the population. The objective was to analyze the prevalence of PTSD symptoms in persons who experienced the 2017 earthquakes in Mexico. A probabilistic sample of 1539 participants from Mexico City, the State of Mexico, Chiapas, Puebla, Morelos and Oaxaca during November and December of 2017 was screened using the Davidson Trauma Scale (DTS) for symptoms of post-traumatic stress. The prevalence of PTSD symptoms was 34.6%, with greater effects on the inhabitants of Oaxaca, Morelos and Puebla, women, indigenous people and people who experienced damage to their homes ($p = 0.001$). The DTS had a moderate negative correlation with the RS-14 and a Cronbach's alpha coefficient of 0.957. The confirmatory factor analysis generated four factors that explain 50% of the variance, compatible with a Dysphoria model. We can conclude that one in three people exposed to earthquakes had symptoms of post-traumatic stress.

1. Introduction

In September of 2017, Mexico experienced several dramatic weeks from two earthquakes that gained international notoriety as a result of the destruction they caused in six states.

The first earthquake occurred on September 7th in the southern part of the country, with the epicenter in the area of Tehuantepec, Oaxaca, and was the most severe (8.2) in the last 100 years in Mexico (National Seismological Service UNAM, 2017a). The government's civil protection agency reported 98 deaths and more than 120,000 damaged buildings in 4400 communities in the states of Oaxaca and Chiapas (CENAPRED, 2018). The federal government issued an Extraordinary Emergency Declaration for the states of Chiapas and Oaxaca (Official Gazette of the Federation, 2017), so that local authorities could have resources to meet the food, shelter and health needs of the affected population.

The second earthquake occurred on the 19th of September (National Seismological Service UNAM, 2017b), with the epicenter on the border of the states of Morelos and Puebla. This quake had a magnitude of 7.1, caused 369 deaths and major damage to 1000 buildings that made them unsuitable for use (CENAPRED, 2018). Government authorities issued a Disaster Declaration for Mexico City, and the States of Mexico, Morelos, Puebla and Guerrero (Official Gazette of the Federation, 2017).

Earthquakes are stressful events for affected communities, as they cause a great psychosocial impact (Abeldaño et al., 2014; Abeldaño and Fernandez, 2016; Leiva-Bianchi et al., 2012; Xu and He, 2012). However, not all people respond to the stress generated by a disaster in the same way (Kukihara et al., 2014), and some face the adverse situations that appear after an earthquake with considerable negative effects for their psychosocial functioning (Fu et al., 2014).

There are several scales used to identify symptoms of post-traumatic stress in the general population. The Davidson Trauma Scale (DTS) developed in the 1990s is one of the most widely used for population screening (Davidson et al., 1997). It has been used in various trauma conditions and in the 2010 Chilean earthquake (Abeldaño et al., 2014; Kevan, 2017; Leiva-Bianchi and Araneda, 2013).

Davidson grouped symptoms into three categories based on the diagnostic criteria of the DSM IV; criterion B, Intrusive Re-experiencing; criterion C, Avoidance and Numbing; and criterion D, Hyperarousal (American Psychiatric Association, 1994). A short time later King et al. (1998) suggested that the same scale identified symptoms under a different dimensional structure, considering four factors (Re-experience, Avoidance, Numbing, and Hyperarousal). Simms et al. (2002) later proposed re-categorizing those four factors as Re-experience, Avoidance, Dysphoria and Hyperarousal.

At present, the DSM V considers four diagnostic criteria; criterion B, Re-experience; criterion C, Avoidance; criterion D, Negative alterations in cognition and mood; and criterion E, Hyperarousal (American Psychiatric Association, 2013).

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Mexico has a high incidence of disasters (Abeldaño Zúñiga and González Villoria, 2018), however there are no studies of the frequency of post-traumatic stress symptoms in the population associated with these events, partly due to the sudden occurrence of earthquakes. PTSD studies in Mexico have been only focused on violent events. This study is the first to analyze PTSD symptoms in the face of a major disaster in Mexico.

The objective of this study was to identify the frequency of symptoms of post-traumatic stress in the Mexican population affected by the 2017 earthquakes.

2. Methods

2.1. Study setting

A descriptive cross-sectional study was carried out between the months of November and December 2017, with participants from Mexico City and the States of Mexico, Oaxaca, Chiapas, Puebla and Morelos. The screenings took place between the second and third months (between the 8th and 17th week after the first earthquake) after the earthquakes, as the criteria for the duration of stress must be greater than one month (criteria B, C, D, E, DSM V). Those states were selected, as they were the most affected by the earthquakes, and had Declarations of Extraordinary Emergency from the federal authorities. The state of Guerrero could not be accessed due to operational difficulties.

The data supporting this research is available in a public repository (Abeldaño Zuñiga, 2018).

2.2. Sample

The study was conducted by academics from the Postgraduate Studies Division of the Universidad de la Sierra Sur, Oaxaca, Mexico. A probabilistic sampling was designed in multiple stages. In the first stage, the participating states were selected, emphasizing the states most affected and which had an official Declaration of Extraordinary Emergency. In the second stage, participating municipalities were chosen within the previously selected states. In the third stage, people of both sexes, age 18 or more, who were residents of the chosen municipalities at the time of the earthquakes, and who would voluntarily respond to the survey, were selected. The final sample consisted of 1539 participants, who were approached and personally interviewed through a population and household survey. Due to housing damage, household surveys were not possible in every case, and various participants were interviewed in shelter facilities, municipalities and other community facilities.

2.3. Measures

A block of questions was used for the socio-demographic characterization of the sample, following the formats used in the Post-Earthquake Survey of Chile in 2010 (Abeldaño et al., 2014; Social Observatory, Ministry of Social Development of Chile, 2010). A filter question was used to investigate whether they were actually in the affected municipalities at the time of the earthquakes.

The symptoms of post-traumatic stress were evaluated with the Davidson Trauma Scale (Davidson et al., 1997) validated in Spanish by Bobes et al. (2000) in Spain. The same scale was used in Chile for PTSD screening after the 2010 earthquake (Abeldaño et al., 2014; Leiva-Bianchi and Araneda, 2013). This scale consists of 17 items that assess the severity and frequency of symptoms in individuals who have experienced trauma. At the time of its creation, it included 17 symptoms of PTSD according to DSM IV criteria, grouped in a three-factor model; intrusive memories and re-experience, avoidance and dullness, and hyper-activation (Davidson et al., 1997). However, with the entry of the DSM V, several authors have grouped symptoms into a 4-factor model as re-experience, avoidance, dysphoria and hyper-activation, or four factors grouped as re-experience, avoidance, dullness and hyper-activation, according to the diagnostic criteria of the DSM V (Kevan, 2017; Kontoangelos et al., 2017; Leiva-Bianchi and Araneda, 2013; Mason et al., 2013; McDonald et al., 2008; Caraballo et al., 2013; Simms et al., 2002).

For each item the frequency and intensity be is scored using a 5-point Likert scale (from 0, never or null intensity, to 4, daily or extreme intensity) taking as a temporal reference the week prior to the application of the instrument, with a maximum possible score of 136 and a cut-off point of 40.

Resilience was measured using the Spanish validated version of the RS-14 Resilience Scale (Sánchez-Teruel and Robles-Bello, 2015), with specific modifications introduced referring to the Mexican earthquakes. This scale consists of 14 items that measure the degree of individual resilience, considered as a positive personality characteristic that enables the individual to adapt to adverse events. In previous studies, this scale showed validity and reliability coefficients (Sánchez-Teruel and Robles-Bello, 2015). The 14 items of the scale are grouped into two factors: Factor I "Personal Competence", composed of 11 items that refer to self-confidence, independence, decision, ingenuity and perseverance; and Factor II "Acceptance of oneself and of life", comprising three items that refer to adaptability, balance, flexibility and a stable life perspective. The total score of the RS-14 scale can range from 14 to 98 points, from which categories are obtained and interpreted according to the following cut-off points (Sánchez-Teruel and Robles-Bello, 2015): Very Low resilience: 14–30, Low resilience: 31–48, Normal resilience: 49–63, High resilience: 64–81 and Very High resilience: 82–98.

Filter questions were included in order to find participants with a self-reported diagnosis of depression. We did not found prior trauma experiences, such as the 1985 Mexico City earthquake, that could trigger PTSD symptoms. We are now conducting a qualitative study to find persons who experienced both the 1985 and the 2017 earthquakes. At the time of this study, none of the participants reported receiving any psychological therapy after the earthquake.

2.4. Statistical analysis

The correlation of the DTS and the RS-14 was evaluated, seeking moderate negative correlations (between -0.3 and -0.5) that would indicate the possibility of analyzing divergent validity between both scales.

The reliability of both scales was measured through the internal consistency test where Cronbach's alpha coefficient and the Spearman-Brown coefficient (with the split-half technique) were obtained.

To test the extent to which the posttraumatic stress construct was different from the resilience construct, an exploratory factorial analysis was carried out using the main component method of the DTS and RS-14 items, specifying two factors, with Varimax rotation. Subsequently, an exploratory factorial analysis of the DTS was carried out, using the principal component method, with Varimax rotation, and with factor extraction from eigenvalues greater than one, with the purpose of observing latent factors that underlie the factorial structure of the scale.

Finally, assuming the non-normality of the DTS data after analyzing its asymmetry and kurtosis, we proceeded to perform a confirmatory factorial analysis with the Robust Maximum Likelihood method to obtain the construct validity coefficients.

At this point three models were tested (Table 1):

1 Davidson's original model, considering three categories based on the diagnostic criteria: R (Re-experience), A / N (Avoidance / Numbing) and H (Hyperarousal) (Davidson et al., 1997).
2 The Numbing Model (King et al., 1998; McDonald et al., 2008), considering four factors: R (Re-experience), A (Avoidance), N (Numbing) and H (Hyperarousal).
3 The Dysphoria Model (Simms et al., 2002), considering four factors:

Table 1
Davidson Trauma Scale (DTS) items, and proposed items mapping for Confirmatory Factor Analysis.

	Ítems	1	2	3
DTS1	You have had some images, memories or painful thoughts about the earthquake	R	R	R
DTS2	You ever had nightmares about the earthquake	R	R	R
DTS3	You have felt that the earthquake was happening again, as if you were reliving it.	R	R	R
DTS4	There are things you have made to remember it.	R	R	R
DTS5	You have had physical sensations by memories of the earthquake (such as sweating, tremors, palpitations, dizziness, nausea or diarrhea)	H	H	H
DTS6	You have been avoiding thoughts or feelings about the earthquake	R	R	R
DTS7	You have been avoiding doing things or being in situations that reminded the earthquake	A/N	A	A
DTS8	You have been unable to recall important parts of the earthquake	A/N	A	A
DTS9	You have had trouble enjoying things	A/N	N	D
DTS10	You have felt distant or away from people	A/N	N	D
DTS11	You have been unable to have feelings of sadness or affection	A/N	N	D
DTS12	You have had difficulty imagining a long life and meet your goals	A/N	N	D
DTS13	You have had difficulty initiating or maintaining sleep	A/N	N	D
DTS14	You have been irritable or have had fits of anger	H	H	D
DTS15	You have had difficulty concentrating	H	H	D
DTS16	You have been nervous, easily distracted, or "on guard"	H	H	D
DTS17	You have been nervous or have easily frightened	H	H	H

R (Re-experience), A (Avoidance), D (Dysphoria) and H (Hyperarousal).

The three models were tested in the total sample of 1539 respondents and in the sub-sample of 533 people who showed symptoms of post-traumatic stress.

The final evaluation of the fit of the models and the choice of the best model was made with the determination of the following indices: Chi-Square, standardized root-mean-square residual (SRMR), root-mean-square error of approximation (RMSEA), Bentler–Bonett normed fit index (NFI), comparative fit index (CFI), Tucker-Lewis index (TLI) and the Akaike Information Criterion (AIC) (Hu and Bentler, 1999).

According to Hu and Bentler (1999), the guidelines followed for the valuation of the fit indices of the models tested were: NFI, CGI and TLI with a 0.95 cut-off point, SRMR with a 0.08 cut-off point and RMSEA with a cut-off point of 0.06. The AIC was used to compare the three models, choosing the model with the best fit and with the lowest AIC (since they are non-nested models). Analyses were performed with SPSS and AMOS software.

2.5. Ethical considerations

The Institutional Review Board of the University of the Sierra Sur in Oaxaca, Mexico approved this research project with registry code IISSP/SSA/01/2017.

3. Results

3.1. Symptoms of post-traumatic stress

The post-earthquake survey was applied to 1555 people with a 99% response rate. Results were reported for 1539 respondents, and 16 people declined to participate. The average age was 36.8 years (SD 12.7) and 53.1% of the sample was female. 10.9% of respondents self-identified as indigenous people. 20.8% of the sample was from Mexico City, 20.5% from the state of Oaxaca, 18.8% from the state of Morelos, 17.2% from the state of Puebla, 13.8% from the state of Mexico, 6.8% from the state of Chiapas and 2.3% from other states.

The overall prevalence of positive screening for symptoms of post-traumatic stress was 34.6% (95% CI = 32.3 − 37.1%) in the general population, but higher prevalence was observed in the states of Oaxaca, Morelos and Puebla. There was also a higher prevalence in women ($p = 0.001$), those who self-identified as indigenous ($p = 0.001$) and persons who experienced with some type of damage (minor or greater) to their homes ($p = 0.001$) (Table 2).

3.2. Reliability

The reliability analysis of the DTS through Cronbach's alpha coefficient was 0.957, interpreted as very good. Individually, the items on the scale had Cronbach's alpha coefficients between 0.953 and 0.957, so the elimination of any element improves the reliability of the instrument. Because a re-test could not be applied, the Spearman-Brown and Guttman coefficients of 0.901 were evaluated.

3.3. Divergent construct validity

In the divergent construct analysis phase between the DTS and the RS-14, moderate negative correlations were found: $r = -0.36$ between DTS and RS-14 (total score), $r = -0.36$ between DTS and Personal Competence dimension of the RS-14, and $r = -0.32$ between DTS and the Self-acceptance dimension of the RS-14. It was proposed to accept a cut-off point of -0.3 (Squassoni et al., 2016), so it is assumed that both scales correlate divergently because they are measuring different constructs.

To test the extent to which the Posttraumatic Stress construct was different from the Resilience construct, exploratory factor analysis was carried out between both scales with the extraction of two factors to sharpen the contrast between the factors. In this analysis, each of the PTSD items and the Resilience items had the greatest load on the expected factor. The two-factor EFA explained 57.5% of the total variance (Table 3).

3.4. Construct validity

The construct validity of the DTS was tested through an EFA of main components, with extraction of factors with eigenvalues greater than one and Varimax rotation that explained 49.9% of the total variance of the scale. Table 4 shows the 4 factors that emerged from this analysis, visualizing a structure compatible with the Dysphoria Model (Simms et al., 2002) where the items are grouped in the constructs: R (Re-experience), A (Avoidance), D (Dysphoria) and H (Hyperarousal). Except for item 8 with a load of 0.357, all other items had high loads in their respective factors (Table 4).

3.5. Confirmatory factor analysis

There are several studies that have tested and confirmed the 4-factor models proposed by King et al. (1998) (Numbing Model) and by Simms et al. (2002) (Dysphoria Model), while the proposed 3-factor model of Davidson et al. (1997) has been somewhat relegated. In this study, these three analyses were repeated to evaluate the model that

Table 2
Frequency measures for screening of posttraumatic stress symptoms. 2017 Mexican Post-Earthquake Survey.

Variables	Categories	Negative screening		Positive screening		Total (100%)	*P* value
		n	%	n	%		
State	Mexico City	218	68.1	102	31.9	320	0.001
	Oaxaca	173	54.9	142	45.1	315	
	Morelos	182	63.0	107	37.0	289	
	Puebla	179	67.8	85	32.2	264	
	State of Mexico	148	69.8	64	30.2	212	
	Chiapas	73	70.2	31	29.8	104	
Sex	Female	461	56.4	356	43.6	817	0.001
	Male	546	75.6	176	24.4	722	
Ages	≤ 39 years	552	65.3	293	34.7	845	0.483
	≥40 years	455	65.6	239	34.4	694	
Indigenous	No	923	67.3	448	32.7	1371	0.001
	Yes	84	50.0	84	50.0	168	
Property damage	With some minor or major damage	446	53.8	383	46.2	829	0.001
	No damage	561	79.0	149	21.0	710	
Total		1006	65.4	533	34.6	1539	

Table 3
Exploratory Factor Analysis loadings of DTS and RS-14 items. 2017 Mexican Post-Earthquake Survey.

Items	Factor	
	1	2
DTS1	**0.794**	−0.066
DTS2	**0.734**	−0.103
DTS3	**0.740**	−0.080
DTS4	**0.785**	−0.089
DTS5	**0.783**	−0.085
DTS6	**0.783**	−0.023
DTS7	**0.791**	−0.033
DTS8	**0.623**	−0.085
DTS9	**0.826**	−0.184
DTS10	**0.717**	−0.241
DTS11	**0.624**	−0.090
DTS12	**0.707**	−0.277
DTS13	**0.781**	−0.157
DTS14	**0.726**	−0.263
DTS15	**0.755**	−0.241
DTS16	**0.833**	−0.163
DTS17	**0.845**	−0.130
RS-1	−0.080	**0.545**
RS-2	−0.090	**0.711**
RS-3	−0.319	**0.598**
RS-4	−0.138	**0.789**
RS-5	−0.135	**0.754**
RS-6	−0.158	**0.795**
RS-7	−0.165	**0.739**
RS-8	.013	**0.624**
RS-9	.010	**0.734**
RS-10	−0.206	**0.669**
RS-11	−0.168	**0.833**
RS-12	−0.110	**0.751**
RS-13	−0.136	**0.705**
RS-14	−0.154	**0.807**

Table 4
Exploratory Factor Analysis loadings of DTS. 2017 Mexican Post-Earthquake Survey.

Items	Factor			
	Dysphoria	Re-experience	Avoidance	Hyperarousal
DTS1	0.251	**0.704**	−0.009	0.009
DTS2	0.220	**0.585**	0.232	0.094
DTS3	−0.071	**0.584**	0.301	0.244
DTS4	0.258	**0.638**	0.130	0.161
DTS5	0.011	**0.525**	0.324	0.322
DTS6	0.117	0.268	**0.597**	0.118
DTS7	0.080	0.282	**0.657**	0.100
DTS8	**0.357**	0.286	0.173	−0.066
DTS9	**0.619**	0.375	0.262	0.077
DTS10	**0.697**	0.082	0.243	0.060
DTS11	**0.300**	−0.010	0.465	0.055
DTS12	**0.630**	0.112	0.151	0.045
DTS13	**0.411**	0.300	0.095	0.294
DTS14	**0.677**	0.099	0.027	0.215
DTS15	**0.739**	0.130	−0.021	0.298
DTS16	0.516	0.159	0.023	**0.613**
DTS17	0.197	0.212	0.246	**0.713**

emerged from the sample of those affected by the Mexican earthquakes. In addition, the models were repeated in the total sample, and in the sample with positive screening results, to evaluate which had a better fit with the CFA Model.

The criteria of Hu and Bentler (1999) were followed to evaluate the fit of the models. They suggest that none of these have an excellent fit, but the Dysphoria and Numbing Models have acceptable fits with upper CFI and TLI at 0.90 and a lower SRMR 0.08 for the total sample. Of these two models, the Dysphoria Model was chosen as the best fit following the criterion of the lowest AIC, as suggested by McDonald et al. (2008). The Dysphoria Model followed the same distribution of scale items that had been preliminarily observed in the EFA Model: R (Re-experience), A (Avoidance), D (Dysphoria) and H (Hyperarousal).

The samples where only the positive screening cases were selected did not have a satisfactory adjustment (Table 5).

4. Discussion

This is the first study to address the psychosocial impact in Mexico of a disaster situation at the national level, as existing studies focus mainly on issues related to violence (Reed et al., 2016).

The analyses were based on the availability of the Davidson Trauma Scale (DTS), a widely used instrument available in several languages and in different countries to determine the presence of symptoms of post-traumatic stress in the general population (Bobes et al., 2000; Davidson et al., 1997; Kevan, 2017; King et al., 1998; Leiva-Bianchi and Araneda, 2013; McDonald et al., 2008; Caraballo et al., 2013; Simms et al., 2002).

The prevalence of symptoms of post-traumatic stress observed in Mexico was higher than in the Chilean earthquake (Abeldaño et al., 2014), and lower than in the Wenchuan earthquake (Wu et al., 2016). Gender differences were consistent with other findings related to various traumatic events in other Latin American and European countries (Abeldaño et al., 2014; Ditlevsen and Elklit, 2012), where women with lower educational and income levels were the most affected. These results are consistent with the burden of greater risk for women in earthquake disaster situations such as the 2008 Wenchuan, China earthquake (Zhang and Ho, 2011), and in terrorist attacks (DeLisi,

Table 5
Fit indices for tested models. 2017 Mexican Post-Earthquake Survey.

Model	Sample	Chi2	*Df*	IFC	TLI	NFI	RMSEA	SRMR	AIC
Dysphoria	1539	1310.5	113	**0.94**	0.93	**0.94**	0.083	**0.041**	**1424.4**
	533	701.6	113	0.84	0.81	0.82	0.093	0.071	815.6
Numbing	1539	1346.1	113	**0.94**	**0.92**	**0.94**	0.084	**0.040**	1460.0
	533	741.1	113	0.83	0.79	0.83	0.096	0.071	855.0
Davidson	1539	1978.8	116	0.90	0.88	0.90	0.102	0.049	2086.8
	533	1000.0	116	0.76	0.72	0.72	0.113	0.085	1108.0

2003; Galea et al., 2002).

The indigenous population in the states of Chiapas, Oaxaca and Puebla suffered proportionally greater effects; of the 612 municipalities affected by the earthquakes, 50% had an indigenous population of 40% (CENAPRED, 2018). Their greater frequency of symptoms of post-traumatic stress is consistent with other studies of indigenous communities that show a higher prevalence of mental disorders, including PTSD, although they were not evaluated in disaster situations (Heffernan et al., 2015; Nadew, 2012; Nasir et al., 2018; Ross et al., 2018). It must be emphasized that indigenous communities are more vulnerable to disasters than non-indigenous communities because they have been deprived of their traditional territories and resources, which affects both their physical and cultural survival. This further weakens their ability to cope with disasters (Fuente Carrasco, 2012).

As to the reliability of the scale, the behavior of the coefficients was similar to that previously observed by other studies, where the DTS had a very good internal consistency (Bobes et al., 2000; Davidson et al., 1997; McDonald et al., 2008; Caraballo et al., 2013; Simms et al., 2002). In this study, internal consistency can be graded as excellent (Cronbach's alpha = 0.957), if it were very close to 0.99 there could be items that are measuring the same symptom simultaneously.

Including a concurrent measurement with other scales that measure the same construct could have increased the strength of this study, but a measure of divergence, the RS-14, was included to analyze the resilience of the population affected by the Mexican earthquakes. The negative correlation obtained between both scales was satisfactory, according to the criterion defined by Squassoni et al. (2016) in community mental health.

The 17 items In the EFA maintained factorial groupings similar to Simms et al. (2002), who described a dysphoria-oriented model. Consequently, the factorial loads were very different from those described by the original authors (Davidson et al., 1997), and the model oriented to the Numbing symptoms described by other authors (King et al., 1998; McDonald et al., 2008).

As expected, this study found that the 4-factor Dysphoria model (according to the DSMV) fit well with the data in the CFA in the total sample, which is very consistent with other studies in samples that were exposed to other types of traumatic experiences (Forbes et al., 2015; Simms et al., 2002).

Among the limitations of the study, it is recognized that this study did not contemplate the application of a re-test. In addition, due to the characteristics of the study, the national scope was privileged and it was not possible to apply a gold standard.

In conclusion, it can be affirmed that this application of the DTS in the population exposed to the 2017 Mexican earthquakes was reliable and its psychometric properties were consistent with the Dysphoria model. In addition, the results obtained in the screening show that the symptoms of post-traumatic stress were more frequent in women, indigenous people exposed to earthquakes, and in persons who had damage to their homes.

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All authors declare that there are no conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.04.003.

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