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RESEARCH PAPER

Posttraumatic Growth in Children and Adolescents Exposed to the 2010 Earthquake in Chile and Its Relationship with Rumination and Posttraumatic Stress Symptoms

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Abstract The aim of this study was to assess a predictive model of posttraumatic growth and posttraumatic stress symptoms in children and adolescents exposed to the earthquake in Chile in 2010. 325 children (47.4% male), aged between 10 and 15 years, were surveyed 12 months after the earthquake. The following tests were administered: the posttraumatic growth inventory for children in its brief version of Kilmer et al., the child PTSD symptom scale of Foa et al., the rumination scale for children of Crider et al., along with a scale to assess the trauma severity and a socio-demographic questionnaire. The model was assessed through a path analysis, which showed that deliberate rumination mediated the relationship between trauma severity and intrusive rumination with posttraumatic growth, that intrusive rumination mediated the relationship between the severity of the event and posttraumatic stress symptoms and that the latter mediated the relationship between intrusive rumination and posttraumatic growth. The sex was included as control variable in the path model. The final model achieved adequate fit indexes. The relevance of rumination processes for the development of the psychological consequences in children and adolescents following a natural disaster and their implications for clinical is discussed.

Keywords Mental health · Path analysis · Post traumatic stress disorder · Repetitive thinking

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1 Introduction

Natural disasters can affect the psychological well-being and mental health of people, both adults and children and adolescents (Kun et al. 2009). The emotional responses of children and adolescents to these disasters can range from minimal change and brief duration without necessarily implying a pathology (Cohen et al. 2009), to the emergence of psychopathological responses, such as posttraumatic stress (Alisic and Kleber 2010; Norris and Elrod 2006), either in the form of disorder (PTSD) or symptoms (PTSS). Nevertheless, it has been shown that children and adolescents could also resist unfavorable situations with an unexpected strength (Alisic et al. 2008), even promoting a learning or perception of positive changes as a result of the struggle undertaken before a major life crisis. We can call this responsel Posttraumatic Growth (PTG) which manifests itself through changes in oneself, changes in relationships and changes in the philosophy of life and spirituality (Calhoun et al. 2010; Tedeschi and Calhoun 1996).

While PTG has been studied primarily in adults (García et al. 2016; Siqveland et al. 2015), it has also been studied in children and adolescents. Cohen (1998) point out that children are less resistant than adults, which means that children experiencing high levels of stress during childhood and have less potential to develop PTG, when compared to adults. Nevertheless, there is evidence that suggests that PTG is possible among younger populations (Meyerson et al. 2011). Research, such as that conducted by Cryder et al. (2006) shows that children from 6 years old have reported some levels of PTG after a potentially traumatic event. PTG has been reported in children who have faced events like life threatening diseases (Barakat et al. 2006), traffic accidents (Salter and Stallard 2004), violence in the community (Park and Ai 2006), terrorists events (Kimhi et al. 2009; Laufer and Solomon 2006; Milam et al. 2005), natural disasters (Cryder et al. 2006; Hafstad et al. 2010; Kilmer and Gil-Rivas 2010; Yu et al. 2010) and other events (Alisic, et al. 2008; Ickovics et al. 2006 Taku et al. 2012).

One of the important factors for the development of PTG in adults is the questioning that shatters the basic assumptions of the person (Janoff-Bulman 1992; Linley and Joseph 2004; Tedeschi and Calhoun 2004). Questioning basic assumptions produces an emotional distress which leads to cognitive processing of the event in the form of repetitive thinking about what happened, which referred to ass rumination (Watkins 2008). Ruminations, initially of intrusive character, could be replaced by a more deliberate style of rumination (Taku et al. 2009), strongly focused on trying to understand the events and their implications (Cann et al. 2011). This would lead to PTG (García et al. 2014a, 2016.). On the other hand, the maintenance of intrusive ruminations in time would relate to PTSS (Triplett et al. 2012).

In the case of children and adolescents, it is necessary to address how the cognitive processing of potentially traumatic events, leading to PTG or PTSS, compared to adults (Cryder et al. 2006). A study conducted by Milam et al. (2005) found a positive relationship between age and PTG among adolescents, proposing that a certain level of cognitive maturity would be necessary to find the meaning or identify the most remarkable changes as a result of trauma. At the same time, the results of the research of Cryder et al. (2006) reported that rumination did not correlate directly with PTG. On the other hand, the results of other studies with children (Kilmer et al. 2009; Kilmer and Gil-Rivas 2010) reported that both intrusive and deliberate rumination are central to the development of PTG. Deliberate rumination was the only significant predictor of PTG, within a model that

also included caregiver coping, perception of competence and intrusive rumination, a year after Hurricane Katrina (Kilmer and Gil-Rivas 2010).

Another factor with possible influence on PTG and PTSS is the severity of the event. The meta-analysis of Helgeson et al. (2006) found that a higher objective severity and a higher perceived stress were positively associated with a greater PTG. In turn, subjective severity has a stronger relationship with mental health problems in adolescents than objective severity (Braun-Lewensohn et al. 2009). Therefore, trauma severity would be a precondition since probably the severity of the event itself leads to a strong questioning of beliefs and suffering, thereby facilitating growth (Páez et al. 2011). According to Cryder et al. (2006), the events experienced by children should reach a sufficient threshold of disturbance or trauma in order to produce PTG. Nevertheless, the same trauma severity has a direct relationship with PTSS or PTSD (Brewin et al. 2000), which also leads to both growth and symptoms, correlate positively (Helgeson et al. 2006; Shakespeare-Finch and Lurie-Beck 2014), which has also been observed in studies with children and adolescents (Alisic et al. 2008; Kilmer et al. 2009).

Thus, it is important to wonder whether it is not precisely the presence of PTSS which creates the conditions for developing PTG. In a study of adults conducted by Morris and Shakespeare-Finch (2011), it was observed that high levels of posttraumatic stress are a positive predictor of PTG, probably because these levels of discomfort are a necessary condition for the questions that lead one to learn from experience. Another alternative for this relationship is that they are two sides of the same coin; however, Zoellner and Maercker (2006) reject this option noting that PTG is not the same as an increase in well-being or decrease in distress. In this way, growth and stress can coexist for some people. Nevertheless, no studies have been observed with children relating both consequences.

In order to explore this, the objective of this study is to prove a hypothesized model that from the individuals perception of the severity of an event, repetitive thinking occurs, either of intrusive or deliberate nature. Intrusive rumination leads directly to PTSS, however, deliberate rumination leads to PTG, partially mediating the relationship of these responses to the severity of the event. The full mediation of deliberate rumination in the relationship between intrusive rumination and PTG is also proposed. In turn, it is proposed that PTSS is a direct predictor of PTG. This hypothesized model is shown in Fig. 1.

In addition an alternative model is proposed whose only difference is that the influence of PTSS on PTG is fully mediated by deliberate rumination. The sample, composed of children and adolescents exposed to the 2010 earthquake in Chile, was chosen because they are among the people most vulnerable to the negative effects of disasters (Bustos et al.

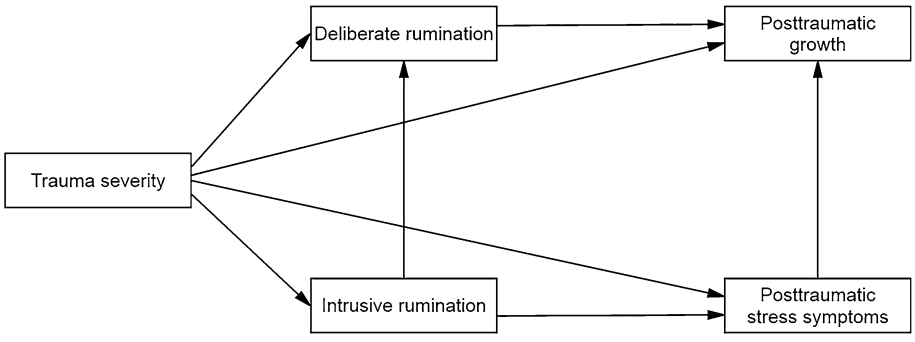

Fig. 1 Hypothesized model

2009), in this case, they were affected by one of the 10 largest earthquakes recorded in modern history (United States Geological Survey 2010). One of the most observed consequences of such natural disasters is the PTSS (Norris and Elrod 2006; Yelland et al. 2010). Furthermore, studies have found that PTG can coexist with PTSS in both adults and children (Shakespeare-Finch and Lurie-Beck 2014).

2 Method

2.1 Research Design

This study uses a quantitative, descriptive and correlational research design. The data were taken at a single point in time, which corresponds to a cross sectional study.

2.2 Participants

The participants consisted of 325 children and adolescents exposed to the earthquake and/or tsunami in the central-southern Chile in February 2010. The sample consisted of 47.4% males and 52.6% females, aged from 10 to 15 years ($M = 12.76$, $SD = 1.52$), of which 42.5% were between 10 and 12 years and 57.5% between 13 and 15 years.

2.3 Instruments

Posttraumatic growth in children was assessed with the PTGi-C-R (Kilmer et al. 2009), an instrument validated for use in Chilean population by Andrades et al. (2016). It consists of 10 items that are answered on a Likert scale from 0 (no change) to 3 points (a lot). This instrument has shown adequate internal reliability ($\alpha = .77$) and temporal stability ($r = .44$) (Kilmer et al. 2009). In the present study, an internal consistency was obtained through Cronbach's alpha of $\alpha = .92$.

Posttraumatic stress symptoms in children was assessed by the Child PTSD Symptoms Scale (CPSS) of Foa et al. (2001), whose psychometric properties were studied by Rincón et al. (2014) for children exposed to the earthquake in Chile. The scale is based on the diagnostic criteria of DSM-IV criteria for PTSD and consists of 17 items with Likert response related to the frequency of symptoms manifestation of this disorder which ranges from 0 (never) to 4 (9 times or more), with a total score ranging from 0 to 68 points. The psychometric properties of the original version indicate adequate internal consistency ($\alpha = .89$) and temporal stability ($r = .84$). In the present study, an $\alpha = .89$ was obtained.

Rumination was assessed by the Rumation Scale for Children (Cryder et al. 2006), a scale of 5 items that evaluates the intrusive and deliberate rumination. It was translated into Spanish by a professional translator, a psychologist who was a native speaker of English and two bilingual psychologists. After this a cross translation of the instrument was conducted and applied to 17 children to assess the comprehension of the items in the range of 10 to 15 years old. It uses a Likert-type scale from 0 (don't think about this) to 3 (think a lot about this). In the present study, an $\alpha = .71$ was obtained for deliberate rumination subscale and .75 for intrusive rumination subscale.

The severity of the potentially traumatic event was assessed with an adaptation for earthquakes of the Exposure to Traumatic Events Questionnaire. It was developed by Vernberg et al. (1996) in order to assess exposure to Hurricane Katrina. It consists of 17

items with two possible answers (yes/no), of which an item refers to the direct perception of threat to the child's own life, six items related to specific threatening events observable during the earthquake, and ten items related to disruptive experiences and post-disaster losses. In the present study, an $\alpha = .80$ was obtained.

A socio-demographic questionnaire assessed information about age, sex, city of residence at the time of the earthquake, and city of current residence.

2.4 Procedure

The data collection was performed 12 months after the earthquake in Chile on February 27, 2010. The sampling was non-probabilistic and by convenience, resorting to children those attending schools in the tsunami-affected coastal areas. For this, it contact was established with municipalities and social organizations in the affected area. Thereafter the lead author administered the questionnaires to children in their homes or classrooms. The questionnaires were self-administered in the presence of the researcher, after parental consent and assent of children was obtained. Ethical approval for the study was obtained from the doctoral commission in psychology of the Complutense University of Madrid.

2.5 Analysis of Data

First descriptive analysis of the study variables was performed. Differences in age and sex groups with the in the study variables was evaluated using the *t* student. Thereafter the relationship between the variables was evaluated using the Pearson *r* correlation and multiple linear regressions.

Path analysis was used to assess the hypothesized model (see Fig. 1). For this, an analysis of the assumption of multivariate normality through the coefficient of Mardia was conducted, using as a parameter a value lower than 70, limit recommended by Rodríguez and Ruíz (2008) to use the maximum likehood estimation method. It is preferred over others by allowing the contrast of hypotheses of the estimates. The following fit indexes and criteria were used (Hu and Bentler 1999; Yu 2002): (a) χ^2: no significant values indicate a good fit, (b) χ^2/gl: a good fit is indicated by values lower than 2 (c) CFI and TLI: an acceptable fit is given by values $\geq$.90, a good fit is indicated by values $\geq$.95, (d) RMSEA: an acceptable fit is indicated by values $\leq$.08 (90% CI $\leq$ .10), a good fit is indicated by values $\leq$.05 (90% CI $\leq$ .08).

To evaluate the mediations, a corrected-bias bootstrap estimation was performed with 2000 samples bootstrap and a 95% confidence interval. In this case, mediation exists if the zero is not included in the interval confidence (MacKinnon et al. 2004).

The statistical treatment of data was conducted through the Statistical Package for the Social Sciences (SPSS) version 22.0 and AMOS SPSS v.20.

3 Results

No significant differences were found in trauma severity, intrusive rumination, deliberate rumination and PTG between boys and girls. With regard to PTSS; males had significantly lower levels than females (see Table 1). With regards to age group (10 to 12 and 13 to 15 years), no significant differences were found in any of the variables.

Table 1 Descriptive statistics and t-value for boys (n = 154) and girls (n = 171) in the study variables

Variable	Gender	*M*	*SD*	*t-value*
Trauma severity	Boys	3.32	3.42	−.423
	Girls	3.47	2.93	
Intrusive rumination	Boys	1.05	1.39	−.760
	Girls	1.18	1.65	
Deliberate rumination	Boys	3.08	2.41	−1.220
	Girls	3.42	2.55	
Posttraumatic growth	Boys	24.78	8.13	−1.183
	Girls	25.88	8.63	
Posttraumatic stress symptoms	Boys	16.15	11.01	−1.999*
	Girls	18.87	13.29	

* $p < .05$

In assessing the bivariate correlation of all variables through the statistical correlation *r* of Pearson (see Table 2), all relationships were found to be direct and significant, with the relationship between deliberate rumination and posttraumatic growth being the strongest ($r = .68$), followed by the relationship between intrusive rumination and posttraumatic stress symptoms ($r = .63$).

A simple linear regression was then performed through the introduce method to assess the relative influence of the severity of the event, the intrusive rumination and deliberate rumination on PTSS (see Table 3). The analysis produced an $R^2 = .46$ ($R^2adj = .46$),

Table 2 Pearson r correlations between the study variables (n = 325)

Variable	2	3	4	5
1. Trauma severity	.48***	.54***	.54***	.49***
2. Intrusive rumination	n/a	.46***	.45***	.63***
3. Deliberate rumination		n/a	.68***	.48***
4. Posttraumatic growth			n/a	.58***
5. Posttraumatic stress symptoms				n/a

*** $p < .001$

Table 3 Multiple linear regression model scores for the posttraumatic stress symptoms (n = 325)

Variable	Unstandardized Coefficients		Standardized Coefficients	t value
	B	SE	β	
(Constant)	8.30	.86		9.653***
Trauma severity	.69	.20	.18	3.478***
Intrusive rumination	3.77	.39	.47	9.700***
Deliberate rumination	.83	.25	.17	3.324***

*** $p < .001$

Table 4 Multiple linear regression model scores for the posttraumatic growth (n = 325)

Variable	Unstandardized Coefficients		Standardized Coefficients	t value
	B	SE	β	
(Constant)	15.42	.60		25.616***
Trauma severity	.39	.13	.15	3.159**
Intrusive rumination	−.12	.27	−.02	−.424
Deliberate rumination	1.60	.16	.47	10.194***
Posttraumatic growth	.20	.03	.29	5.817***

** $p < .01$; *** $p < .001$

$F_{(3,321)} = 91.98$; $p < .001$. All predictors were significant; the strongest weight being observed in intrusive rumination ($\beta = .47$).

After that, a multiple linear regression analysis was performed using the introduce method, with the variables severity of the event, intrusive rumination, deliberate rumination, and posttraumatic stress symptoms as predictors of posttraumatic growth (see Table 4). It was obtained an $R^2 = .56$ ($R^2adj = .56$), $F_{(4,320)} = 103.07$, $p < .001$. All predictors, except the intrusive rumination, were significant, being the deliberate rumination the predictor with the greatest weight ($\beta = .47$).

The difference found between boys and girls in PTSS led to the inclusion of two additional models incorporating sex as a control variable: model 3 (hypothesized model plus sex as control variable over PTSS) and model 4 (alternative model plus sex as control variable over PTSS). The Mardia Coefficient was calculated before the analysis in order to evaluate the multivariate normality, obtaining a value of 8.13 so it was possible to use the Maximum Likelihood Estimation Method. The fit indices of each model are observed in Table 5.

From the results, it can be concluded that the model presenting the best fit indices is model 3, in all assessed indices. In this case, it is the only model whose Chi square is not significant, its ratio Chi square/degrees of freedom are near 2 and its RMSEA is less than .08. The final model with standardized weights can be seen in Fig. 2.

Table 5 Fit indices for the models

Model	χ^2 (df)	*p*	χ^2/df	CFI	TLI	RMSEA (90% CI)
Model 1	11.148 (2)	.004	5.57	.99	.93	.12 (.06/.19)
Model 2	39.016 (2)	.000	19.51	.95	.73	.24 (.18/.31)
Model 3	12.217 (6)	.054	2.04	.99	.98	.06 (.00/.10)
Model 4	40.085 (6)	.000	6.68	.95	.87	.13 (.10/.18)

Model 1: hypothesized model. Model 2: alternative model. Model 3: hyphothesized model more sex as a control variable. Model 4: alternative model more sex as a control variable

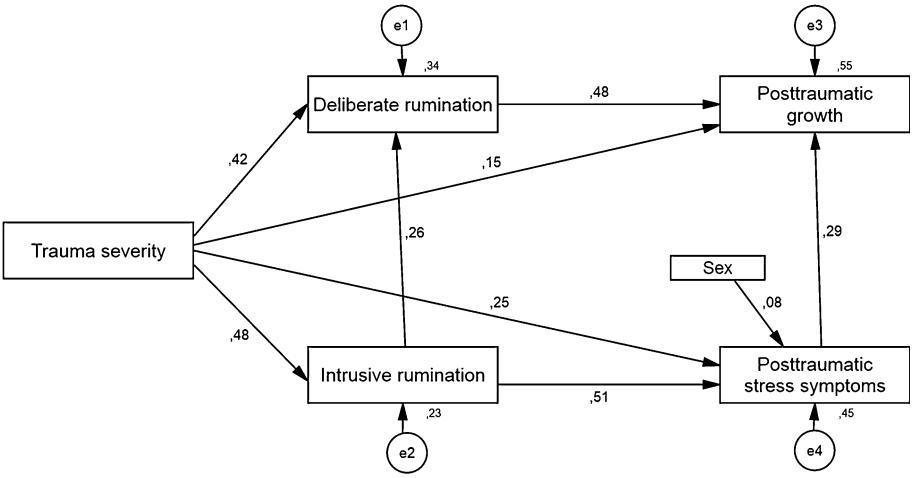

Fig. 2 Final model (values are standardized, all direct effects are significant)

Table 6 The standardized indirect effects, their standard errors, the 95% confidence intervals (CI) for the estimates (lower/upper bound), and p values of according to corrected-bias bootstrap

Path	Estimate	SE	CI 95%	*p*
Trauma severity → Deliberate rumination	.12	.027	.08/.17	.001
Trauma severity → Posttraumatic stress symptoms	.24	.034	.19/.30	.001
Trauma severity → Posttraumatic growth	.40	.037	.34/.46	.001
Inrusive rumination → Posttraumatic growth	.27	.036	.21/.33	.001

Finally, the indirect effects were evaluated in order to determine if the mediations included in the model were significant. The results are shown in Table 6 and show that all mediations were significant.

4 Discussion

This research assessed a model exploring a possible relationship between severity of a potentially traumatic event, intrusive rumination, deliberate rumination, and PTSS, and their influence on PTG in children and adolescents affected by the earthquake in Chile 2010.

In assessing the relationship among the variables, we observe that the strongest relationship of PTG was with the deliberate rumination. This result is consistent with those obtained in adult populations (Avilés et al. 2014; Lindstrom et al. 2013) and previous research with children (Kilmer et al. 2009; Kilmer and Gil-Rivas 2010). It also coincides with the suggestion of a hypothetical model presented by Kilmer et al. (2014) for PTG in children, identifying deliberate rumination as a mediator between other psychological processes and PTG. Deliberate rumination is a constructive version of cognitive

processing, since it involves an analysis of the new situation, the search for meaning and a reassessment of the experience. Therefore, the degree of reflection on the event, would be central in facilitating the development of PTG (Calhoun and Tedeschi 2004), is deliberate rumination which has the strongest direct relationship (Kane 2009).

The study also found that intrusive rumination can give way to a more deliberate rumination. Taku et al. (2009) suggest that after a potentially traumatic event, more automatic than voluntary ruminations of the experiences would be experienced, which would be progressively replaced by a deliberate and thoughtful style of rumination. Calhoun and Tedeschi (2004) note that automatic thoughts about the potentially traumatic event, would be an important factor in determining the evolution of PTG, although part of this is lived in a distressing way.

The high relationship between intrusive rumination and posttraumatic stress symptoms may be due to the fact that after a potentially traumatic event, automatic thoughts of the experiences would be experienced making the presence of posttraumatic stress symptoms possible (Alisic and Kleber 2010; Norris and Elrod 2006; Taku et al. 2009). As people perceived threatened their lives or the lives of their loved ones, higher are reports of PTSS (La Greca and Prinstein 2002). Events such as natural disasters cause the perceived threat of life in many children, although nobody may have been injured or hurt in such an event.

The observed relationship between PTG and PTSS could be explained by the issues raised by Páez et al. (2011), who note that as the event is stressful enough this seems to be a precondition for PTG as the severity of the event itself leads to a strong questioning of beliefs and suffering, which would facilitate PTG. Distress, in this case, could contribute to starting the process and perhaps to maintain growth (Tedeschi et al. 2007). Therefore, stress would enable the cognitive process be maintained and, thus, it would enable the integration of the potentially traumatic event. For this, often symptoms of posttraumatic stress and growth could coexist (Tedeschi and Calhoun 2004). In addition, some studies have shown that the processes involved in both the development of PTSD symptomatology and PTG have in common the perception that the event was severe (Morris et al. 2005; Xu and Song 2011). This would be understandable because it is precisely the perceived event severity which triggers the mechanisms that allow personal growth (Calhoun and Tedeschi 1999). A positive relationship between PTG and PTSS has also been observed in studies with children and young people (Alisic et al. 2008; Kilmer et al. 2009). We believe that the influence of PTSS on the PTG would be mediated by other variables. In this study we tested an alternative model in which this mediation is performed by the deliberate rumination, a model that did not obtain a proper fit, so it becomes necessary further research to identify those variables.

This study has some limitations. Firstly, the data collection was performed 12 months after the earthquake, so the results could have been affected by memory bias. Nevertheless, measurement of the study variables, except for the event severity, was performed considering the current state of the participants and not the memory of a reaction of the past, therefore the effect of bias may have been minimal. Secondly, although this study hypothesizes causal and temporary relations through a Structural Equation Modeling, its design was cross-sectional and correlational, so the final model should be corroborated by further experimental or longitudinal studies.

Thirdly, while this study incorporated important variables according to the literature to explain PTG in children, it may have been relevant incorporating other variables that contribute to a better understanding of the mechanisms involved in posttraumatic growth or in the way from the intrusive rumination to deliberate rumination or in the way from PTSS to PTG, probably mediated by variables that need to be discovered and explored later,

among which may be the beliefs of competence (Cryder et al. 2006; Calhoun et al. 2010) or religiosity (García et al. 2014b).

This study contributes to understanding how the severity of a potentially traumatic event and rumination processes following such an event interact for the appearance of symptoms or posttraumatic growth. It is important to find the psychological processes that lead to PTG in children and adolescents affected by natural disasters to outline strategies promoting reflection in order to overcome the experienced adverse events.

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