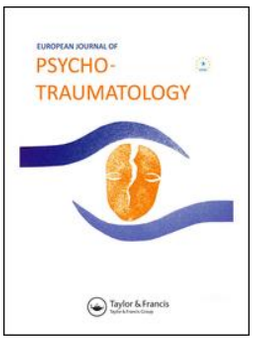

European Journal of Psychotraumatology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/zept20

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To cite this article: Kristin Alve Glad , Nikolai Olavi Czajkowski , Grete Dyb & Gertrud S. Hafstad (2020) Does event centrality mediate the effect of peritraumatic reactions on post-traumatic growth in survivors of a terrorist attack?, European Journal of Psychotraumatology, 11:1, 1766276, DOI: 10.1080/20008198.2020.1766276

To link to this article: https://doi.org/10.1080/20008198.2020.1766276

Published online: 20 Jul 2020.

EUROPEAN JOURNAL OF PSYCHOTRAUMATOLOGY
2020, VOL. 11, 1766276
https://doi.org/10.1080/20008198.2020.1766276

Does event centrality mediate the effect of peritraumatic reactions on post-traumatic growth in survivors of a terrorist attack?

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ABSTRACT

Background: While self-reported post-traumatic growth (PTG) has been documented after a wide variety of potentially traumatic experiences, we need more knowledge on the mechanisms behind PTG to gain a better understanding of this phenomenon.
Objective: We aimed to investigate the hypothesized mechanism of perceived event centrality as a mediator on the pathway between peritraumatic reactions and later PTG.
Method: In total, 204 survivors of the 2011 massacre on Utøya island, participated 4–5 months (T1), 14–15 months (T2), and 30–32 months (T3) post-terror. We applied counterfactually based causal mediation analysis to explore the potential mediating role of survivors' perceived centrality (T2) in linking their peritraumatic reactions (T1) and self-reported PTG (T3).
Results: The vast majority of the survivors reported experiencing some positive changes post-terror, and we found a positive, significant association between survivor's peritraumatic reactions, perceived event centrality and self-reported growth. However, we did not find that centrality significantly mediated the longitudinal association between peritraumatic reactions and later PTG.
Conclusion: Reports of PTG are common post-terror, and peritraumatic reactions and perceptions of centrality may help explain individual differences in trauma survivors' level of PTG. Perceived event centrality about one year post-trauma does not appear to explain the relationship between initial reactions to trauma and subsequent PTG.

¿La centralidad del evento media el efecto de las reacciones peritraumáticas sobre el crecimiento postraumático en los sobrevivientes de un ataque terrorista?

Antecedentes: Si bien el crecimiento postraumático (CPT) auto-reportado se ha documentado después de una amplia variedad de experiencias potencialmente traumáticas, necesitamos más conocimiento sobre los mecanismos detrás del CPT para obtener una mejor comprensión de este fenómeno.
Objetivo: Nuestro objetivo fue investigar el mecanismo hipotético de la centralidad percibida del evento como mediador en la vía entre las reacciones peritraumáticas y el CPT posterior.
Método: En total, 204 sobrevivientes de la masacre de 2011 en la isla de Utoya, participaron 4-5 meses (T1), 14-15 meses (T2) y 30-32 meses (T3) después del ataque terrorista. Aplicamos un análisis de mediación causal contrafactual para explorar el posible papel mediador de la centralidad percibida (T2) de los sobrevivientes al vincular sus reacciones peritraumáticas (T1) y el CPT autoinformado (T3).
Resultados: La gran mayoría de los sobrevivientes informaron haber experimentado algunos cambios positivos después del ataque terrorista, y encontramos una asociación positiva y significativa entre las reacciones peritraumáticas del sobreviviente, la centralidad del evento percibido y el crecimiento autoinformado. Sin embargo, no encontramos que la centralidad mediara significativamente la asociación longitudinal entre las reacciones peritraumáticas y el CPT posterior.
Conclusión: Los reportes de CPT son comunes después del terrorismo, y las reacciones peritraumáticas y las percepciones de centralidad pueden ayudar a explicar las diferencias individuales en el nivel de CPT de los sobrevivientes de trauma. La centralidad percibida del evento aproximadamente un año después del trauma no parece explicar la relación entre las reacciones iniciales al trauma y el CPT posterior.

事件中心性是否可以调节恐怖袭击幸存者的创伤后反应对创伤后成长的影响

背景: 虽然在大量潜在的创伤经历之后记录了自我报告的创伤后成长 (PTG), 但我们需要更多有关PTG背后机制的知识, 以更好地了解这一现象。

ARTICLE HISTORY
Received 24 January 2020
Revised 30 April 2020
Accepted 30 April 2020

KEYWORDS
Posttraumatic growth; peritraumatic reactions; event centrality; trauma survivors; terrorist attack

PALABRAS CLAVE
Crecimiento postraumático; reacciones peritraumáticas; centralidad del evento; sobrevivientes de trauma; ataque terrorista

关键词
创伤后成长; 围创伤反应; 事件中心性; 创伤幸存者; 恐怖袭击

HIGHLIGHTES

- Peritraumatic reactions and perceived event centrality may explain individual differences in trauma survivors' level of post-traumatic growth (PTG).
- Perceived event centrality does not appear to explain the relationship between initial reactions to trauma and subsequent PTG.

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目的: 我们旨在调查事件中心性作为围创伤反应与后来的PTG之间通路的中介变量的假设机制。
方法: 总共有204名经历2011年Utoya岛大屠杀幸存者在恐怖活动后的4-5个月 (T1), 14-15个月 (T2) 和30-32个月 (T3) 参加了研究。我们应用了基于反事实 (counterfactually) 的因果中介分析, 以探索幸存者感知到的事件中心性 (T2) 对围创伤反应 (T1) 和自我报告的PTG (T3) 之间关系的潜在中介作用。
结果: 绝大多数幸存者报告说恐怖袭击后经历了一些积极变化。我们发现幸存者的围创伤反应, 感知的事件中心性和自我报告的PTG之间存在积极的显著关联。然而, 我们没有发现中心性显著中介围创伤反应与后来的PTG之间的纵向联系。
结论: PTG的报告在恐怖袭击后很常见, 创伤前后的反应和对中心性的理解可能有助于解释创伤幸存者PTG水平的个体差异。但创伤后一年左右的事件中心性似乎不能解释创伤初期反应与随后的PTG之间的关系。

While the study of adverse outcomes has dominated the field of psychological reactions to trauma, a growing body of literature is focusing on self-perceived positive post-trauma changes. This is most commonly referred to as posttraumatic growth (PTG), and has been defined as: 'Positive change that the individual experiences as a result of the struggle with a traumatic event' (Calhoun & Tedeschi, 1999, p. 11). Self-reported PTG has been documented after a wide variety of potentially traumatic experiences, including traffic accidents, sexual abuse, combat, terrorist attacks, chronic illness, natural disasters, and other potentially traumatic events (for a review, see Shakespeare-Finch & Lurie-Beck, 2014). Furthermore, observations of growth related behaviour, from significant others in the trauma survivors' social network, have been documented and support the validity of the construct (e.g. Glad, Kilmer, Dyb, & Hafstad, 2019; Shakespeare-Finch & Barrington, 2012). However, as pointed out by Lancaster, Kloep, Rodriguez, and Weston (2013), research on the processes behind PTG, including the cognitive pathways which promote such positive personal changes, is scarce. In this study, we investigated the hypothesized role of survivors' perception of the attack as central to their identity and life story on the pathway towards PTG.

1. Theoretical and empirical framework

The conceptual framework for this paper is the posttraumatic growth model, developed by Tedeschi and Calhoun (1995, 2004); recently revised by Tedeschi, Shakespeare-Finch, Taku, and Calhoun (2018). According to this model, a traumatic event can significantly challenge, and even shatter, an individual's core assumptions about the self and the world. The subsequent emotional turmoil from these shattered assumptions prompts, according to Tedeschi and Calhoun (2004), a need to re-examine pre-trauma assumptions and a struggle to re-establish new useful basic cognitive guides, which incorporates the event and its aftermath. In this process, an opportunity for growth is thought to arise.

According to Tedeschi and Calhoun (2004), a central element in the growth process is the degree to which the survivor is cognitively engaged with the traumatic event and they have postulated that growth seems to be closely connected to 'the development and modification of the individual's life narrative' (p. 12). More specifically, Calhoun and Tedeschi (2006) propose that growth is more likely to occur when the traumatic event disrupts the survivors' life narrative, and they note that the way many survivors make reference to life 'before' and 'after' the traumatic event, illustrates the central role of the event in their personal narrative (Tedeschi & Calhoun, 1995). As pointed out by Bernard, Whittles, Kertz, and Burke (2015), while most measures on posttraumatic reactions do not explore the personal meaning of the traumatic event, and how the event is incorporated into the survivors' personal narrative, one construct which has gained a lot of empirical attention during the last decade in this regard, is 'event centrality'. The centrality of event scale (CES) was developed by Berntsen and Rubin (2006) to assess the extent to which trauma survivors considered a traumatic event to have become a turning point in their life story; a central component of their identity; and a reference point for their everyday inferences. A high score indicates that the trauma survivor perceives the event to have become central to his or her identity and life story. Interestingly, Tedeschi et al. (2018) have included 'centrality of event' as a key factor in the avenue towards growth, together with a 'potentially disruptive (seismic) event', in their revised model of posttraumatic growth (p. 44). Because the CES can be used to assess how central a life event has become for the survivor, it 'seems ideally suited for investigating the hypothesis that the perceived importance of a traumatic event predicts posttraumatic growth' (Staugaard, Johannessen, Thomsen, Bertelsen, & Berntsen, 2015, p. 363).

To date, in line with Tedeschi et al.'s (2018) model, several cross-sectional studies have found a positive association between level of event centrality and PTG, both in student samples (e.g. Groleau, Calhoun, Cann, & Tedeschi, 2013; Lancaster, Klein, Nadia,

Szabo, & Mogerman, 2015; Schuettler & Boals, 2011) and among trauma survivors (Allbaugh, Wright, & Folger, 2015; Kuenemund, Zwick, Rief, & Exner, 2016; Roland, Currier, Rojas-Flores, & Herrera, 2013; Rubin, Boals, & Hoyle, 2014). This positive association persists even when controlling for other known correlates, including rumination, meaning making, depression, posttraumatic stress symptoms, and violence exposure (Boals & Schuettler, 2011; Groleau et al., 2013; Roland et al., 2013), which indicates that event centrality may be a unique predictor of PTG. However, to the best of our knowledge, only two studies have explored the longitudinal association between event centrality and PTG. In the first of these studies, in line with Tedeschi and Calhoun's theoretical framework and the findings from the cross-sectional studies, Staugaard et al. (2015) found that level of event centrality for the most negative event experienced among war veterans during deployment, predicted level of PTG two to four months after deployment, among war veterans. Based on these findings, they argue that the centrality survivors assign to the traumatic experience is a central mechanism in the translation of a traumatic event into positive outcomes. In the second longitudinal study, Blix, Birkeland, Hansen, and Heir (2015) explored the bidirectional association between level of event centrality and PTG among ministerial employees exposed to the Oslo bombing in 2011. They measured both constructs at two different time points (i.e. 10 months and two years after the bombing), and found that the levels of event centrality and PTG were relatively stable over time, and that the constructs were positively associated at both time points. However, they did not find a time-lagged causal effect in any direction between the constructs, and the relationship between event centrality and PTG became significantly weaker over time. The authors concluded that while event centrality may play a role in the development of PTG, their longitudinal findings did not suggest any long-term effects of centrality on PTG. In sum, most existing studies on the association between level of event centrality and PTG are cross-sectional, and many have relied on undergraduate samples. The existing longitudinal studies have used trauma samples, but are scarce and have yielded mixed results.

In the posttraumatic growth model (Tedeschi & Calhoun, 1995, 2004), emotional distress related to a challenging life experience is considered to be a prerequisite for the cognitive processing leading towards growth. In line with this, several researchers have found a positive association between peritraumatic distress and later self-reported PTG (Blix, Solberg, & Heir, 2013; Hafstad, Kilmer, & Gil-Rivas, 2011; Kleim & Ehlers, 2009; Kunst, 2010). Strong peritraumatic reactions can also be hypothesized to be lead to high levels of perceived event centrality, given that highly emotional events tend to be particularly accessible (McGaugh, 2003) and more likely to serve as an organizational skeleton for other autobiographical memories (Pillemer, 1998). Indeed, Berntsen and Rubin (2006) have argued that the memory of a traumatic event, because of its distinctness and strong emotional impact, may become highly central for the survivors identity and personal narrative. Supporting this hypothesis, Blix et al. (2013) found a significant positive association between peritraumatic reactions and level of centrality among individuals present during the 2011 Oslo bombing attack. While we could expect an indirect effect whereby trauma survivor's peritraumatic reactions predict PTG through their contribution to event centrality, perceived event centrality as a potential mediator for growth has not been investigated to date. The current study addresses this gap. The aim was to investigate the relationship between survivors' reactions during the terrorist attack, level of event centrality, and self-reported PTG. More specifically, we tested the hypothesis that event centrality would act as a mediator on the pathway between emotional, cognitive and physiological reactions during the attack and later perceptions of PTG.

2. Method

The present study was based on data collected as part of a comprehensive interview study which was designed to examine the level of posttraumatic stress reactions and potential predictors of PTSD among the young survivors of the terrorist attack on Utøya island in 2011 (for more information, see Dyb et al., 2014). Data was collected at three different time-points post-trauma: 4–5 months (T1), 14–15 months (T2), and 30–32 months (T3).

2.1. The 22nd of July attack

On the 22nd of July, 2011, one man, dressed as a police officer, went to Utøya island, Norway, where a Labour Youth summer camp was being hosted. In total, 564 people were on the island when the perpetrator arrived. Once on the island, he began shooting those he came across. The shooting lasted for approximately 90 minutes and resulted in 69 mortalities; mostly youth or young adults. Because the shooting happened on a small island, which could only be reached (and vacated) by boat, the youth had little possibility to escape (i.e. they had to swim in the cold water). During the massacre, the survivors experienced high levels of trauma exposure, including life threat, witnessing people being injured or killed, hearing people scream in pain and fear, the intense and persistent sound of gun shots, and the

loss of someone close (Glad, Jensen, Hafstad, & Dyb, 2016). The survivors have reported high levels of peritraumatic reactions (Dyb et al., 2014), and high levels of event centrality (Glad, Czajkowski, Dyb, & Hafstad, 2019).

2.2. Participants and procedures

In the first two interview waves, the study had an open cohort design. At T1, the 490 individuals (≥ 13 years old at the time of the attack) who according to police registers survived the massacre were sent postal invitations to participate, including information about the purpose of the study. Upon receiving this letter, three survivors contacted the project group and said that they did not want to participate. Because they had opted out of the study, these individuals were not contacted in the second wave. At T2, the remaining 487 survivors were posted an invitation letter for the second interview wave. At T3, the study had a closed cohort design; only survivors who had participated in the first and/or second wave were invited. Altogether, 355 (72%) of the 490 survivors from Utøya island massacre participated in at least one of the three waves in the longitudinal study: 325 (66%) at T1, 285 (58%) at T2, and 261 (53%) at T3. Their mean age at the time of the attack was 19.4 years (SD = 4.6, range 13.3–56.8, 93.1% < 26), and 47.0% were female. There were no significant differences between survivors who participated or not with respect to sex or age (Stene & Dyb, 2016).

Approximately two weeks after receiving the invitation letter, survivors were telephoned and asked if they were willing to participate. Those who agreed took part in individual face-to-face interviews, performed by trained clinicians. Part of the interview guide consisted of a self-report section, which was completed by the respondents, with the interviewer beside them available for questions. Participation was based on informed consent. Participants aged 16 or older consented themselves, whereas a caregiver consented to participation for younger children, in accordance with Norwegian law. Interviews lasted approximately an hour and a half. If unmet needs were identified during the interview (e.g. for intervention or support), interviewers were instructed to arrange for assistance. The study was approved by the Regional Committee for Medical and Health Research Ethics in Norway. For a more comprehensive description of the participants and procedure, see Dyb et al. (2014).

2.3. Measures

2.3.1. Peritraumatic reactions

Participants' peritraumatic reactions (i.e. cognitive, emotional and physiological reactions during or immediately after the terrorist attack) were measured using six items. Five of these items tapped the A2 criteria in the DSM-IV (i.e. fear, helplessness, horror, confusion, and peritraumatic dissociation), and were extracted from the UCLA PTSD-RI (Pynoos, Rodriguez, Steinberg, Stuber, & Frederick, 1998; Steinberg, Brymer, Decker, & Pynoos, 2004). The sixth item measured rapid heartbeat. Responses were endorsed on a 5-point Likert-scale, ranging from 0 (not experienced at all) to 4 (experienced very much). Peritraumatic reactions were recorded at T1 (α = 0.61), and calculated as a mean score based on the six items.

2.3.2. Event centrality

A short version of the Centrality of Event Scale (CES) (Berntsen & Rubin, 2006) was used to measure how central the terror attack on Utøya island had become for the survivors' identity and life story. The short version is a 7-item questionnaire, tapping three different ways in which the memory of a traumatic event may become highly interconnected in an individual's autobiographical memory: reference point (e.g. 'This event has become a reference point for the way I understand myself and the world'), identity (e.g. 'I feel that this event has become part of my identity'), and turning point (e.g. 'This event permanently changed my life'). Responses are endorsed on a 5-point Likert-scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The CES was calculated as a mean score, with high scores indicating high levels of centrality. Participants completed the CES at T2 (α = 0.86).

2.3.3. Posttraumatic growth

A short version of the Posttraumatic Growth Inventory (Tedeschi & Calhoun, 1996), the Posttraumatic growth short form (PTGI-SF) (Cann et al., 2010) was used to measure self-perceived posttraumatic growth. This is a 10-item questionnaire, consisting of two items from each of the five subscales of the original PTGI; increased personal strength, enhanced appreciation of life, closer relationships, new possibilities and increased spirituality. Responses were endorsed on a 6-point Likert-scale ranging from 1 ('I did not experience this change') to 6 ('I experienced this change to a very great degree'). Participants were asked to report to what degree they had experienced these changes in relation to the terrorist attack. They completed the PTGI-SF at T3 (α = 0.81).

2.4. Data analyses

To assess the relationship between peritraumatic reactions (T1), CES (T2) and PTGI-SF (T3), we performed Pearson correlations. Subsequently, a mediation model in which peritraumatic reactions predicted posttraumatic growth via event centrality

Table 1. Self-perceived posttraumatic growth on the five PTG domains 30–32 months post-terror (n = 259–260).

PTG domain	M (SD)	Interquartile range	Not experienced n (%)	Experienced to a great/very great degree n[a] (%)
Personal strength	4.23 (1.36)	3.5–5	11 (4.2)	108 (23.6)
Appreciation of life	4.19 (1.22)	3.5–5	8 (3.1)	94 (19.2)
Relating to others	3.84 (1.18)	3–4	13 (5.0)	63 (9.3)
New possibilities	2.94 (1.19)	2–4	32 (12.4)	15 (2.7)
Spiritual change	1.83 (1.15)	1–2.5	133(51.4)	8 (1.5)

[a]Number of participants with a mean score between 5 (experienced to a great degree) and 6 (experienced to a very great degree) on each PTG domain.

was fitted, where all variables were adjusted for age and sex. More specifically, we applied causal mediation analysis to study the average causal mediation effect of perceived event centrality linking emotional, cognitive and physiological reactions during the terrorist attack to self-reported posttraumatic growth and the average direct effect (i.e. all effects not mediated through CES) (Imai, Keele, & Tingley, 2010). First, we assessed the potential direct and indirect effect (through CES) of peritraumatic reactions on PTG. Then we estimated the direct and mediated effects as proportions of the total effect, given in percentages.

Causal mediation analysis relies on a sequential ignorability assumption, meaning that there are no unmeasured confounders that causally affect both the mediator and the outcome (Imai et al., 2010). Because this assumption is untestable, a sensitivity analysis is recommended in order to quantify the robustness of the empirical findings when the key assumption is violated (Imai et al., 2010). The sensitivity analysis is based on the correlation ρ between the error terms in the mediation and outcome models. Under sequential ignorability, the correlation is zero. When the estimate for the average causal mediation effect and the average direct effect retain the same sign as the ρ departs considerably from zero, the estimates from the causal mediation analysis are considered to be robust. We interpreted correlation coefficients based on the guidelines provided by Dancey and Reidy (2007).

Descriptive analyses were performed using IBM SPSS statistics for Windows, version 20.0. The causal mediation analysis was conducted using Mplus 8.0 (Muthén & Muthén, 1998–2017).

2.5. Attrition analyses

We calculated the mean score for each measure (allowing one missing), giving us a peritraumatic reaction score on 325 survivors (T1), CES on 281 (T2), PTGI on 260 (T3), and complete data on 204 survivors. Most missing data were due to wave non-response and were handled by listwise deletion. Independent sample t tests indicated no significant differences in age, mean peritraumatic reactions, mean CES, or mean PTGI, among survivors who participated at T1 but not T2, and T1 but not T3 ($p > 0.05$). Similarly, a chi square independence test indicated no sex differences in attrition.

3. Results

3.1. Descriptive analyses

The vast majority of the survivors reported (at least some) positive post-trauma changes; only three had not experienced any PTG. The highest mean scores were found for the domains 'personal strength' and 'appreciation of life', and the lowest mean growth score was found for the 'spirituality' domain (Table 1).

There were low to moderate positive correlations between peritraumatic reactions (T1), CES (T2) and PTGI-SF (T3) (Table 2).

3.2. Event centrality as mediator

In the causal mediation analysis, we did not find that perceived event centrality significantly mediated the association between peritraumatic reactions and later PTG (Figure 1).

The total effect was 0.19 (95% CI: 0.03. 0.33, p = 0.017), representing the sum of the average direct effect (all effects other than the one mediated through CES) and the average causal mediation effect (the effect from peritraumatic reactions through perceived centrality to PTG). Of the total effect, the average causal mediation effect accounted for 22.0%. The average direct effect between peritraumatic reactions and PTG was statistically significant (p = 0.049). Standardized estimates in the path model were 0.15 (p = 0.049) for the path from peritraumatic reactions to PTG; 0.20 (p = 0.012) for the path from

Table 2. Correlations between peritraumatic reactions, event centrality and posttraumatic growth (n = 240–325).

	M (SD)	Peri T1	CES T2	PTGI-SF T3
Peri T1	2.94 (0.79)	-		
CES T2	3.65 (0.88)	0.21 (0.08 – 0.32)	-	
PTGI-SF T3	3.40 (0.88)	0.25 (0.13 – 0.37)	0.22 (0.09 – 0.34)	-

Peri T1 = peritraumatic reactions 4–5 months post-trauma, CES T2 = Centrality of Event Scale 14–15 months post-trauma, PTGI-SF T3 = Posttraumatic growth inventory short form 30–32 months post-trauma. All correlations were significant at the $p \leq .001$ level.

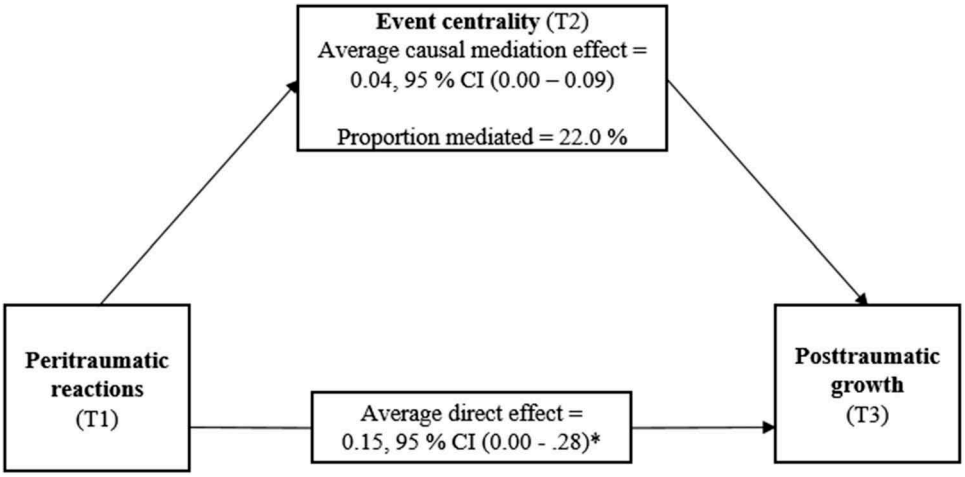

Figure 1. The average direct effect of peritraumatic reactions on posttraumatic growth and the average causal mediation effect from peritraumatic reactions through event centrality to posttraumatic growth (value of $\rho \leq -0.57$). * $p < 0.05$. $N = 204$.

peritraumatic reactions to event centrality; and 0.21 ($p = 0.002$) for the path from event centrality to PTG.

The sensitivity analysis, conducted to evaluate the robustness of the results from the causal mediation analysis, showed that as long as ρ is above −0.2, the indirect effects still had the same sign as estimated. This indicated low robustness of the findings. For the direct pathway, the sensitivity analysis showed that as long as ρ is above −0.57 the direct effects has the same estimated sign (Figure 1), indicating moderate robustness.

4. Discussion

In the present study, we investigated the hypothesized mechanism of perceived event centrality as a mediator on the pathway between survivors' reactions during a terrorist attack and later PTG. We found a positive, significant association between survivor's peritraumatic reactions, perceived event centrality and self-reported growth. However, contrary to our expectation, perceived centrality did not significantly mediate the association between survivors' reactions during the attack and later PTG.

The vast majority of the survivors reported that they had experienced some level of positive change in the aftermath of the terrorist attack on Utøya island. Given the brutal nature of the attack and the profound negative effects it had on the survivor's daily lives and functioning, including the loss of someone close, high levels of psychopathology, and deteriorated school performance (Dyb et al., 2014; Stene, Schultz, & Dyb, 2018), reports of positive changes may seem paradoxical. On the other hand, in light of PTG theory, it is likely that the survivors' assumptions about the world as safe and predictable were severely challenged by the attack (cf. Janoff-Bulman, 1992). Furthermore, because psychological turmoil and distress post-trauma are considered prerequisites for the cognitive processing towards PTG, these aspects of the event and its aftermath may help explain why reports of growth were prevalent in this sample. The survivors particularly reported that they had experienced a new awareness of their personal strength and a new appreciation of life. The fact that the participants were all in life danger on the island, but survived, may in itself have prompted an experience of personal strength. In line with this, Janoff-Bulman (2004) has noted that through experiencing and coping with the debilitating pain and distress of trauma, survivors can become aware of their previously undiscovered strengths. The lowest reports of PTG were on the spiritual domain. This finding is in line with previous studies on growth in Norway (Glad, Jensen, Holt, & Ormhaug, 2013; Hafstad et al., 2011) and was not surprising, given that Norway is one of the most secular countries in the world. Importantly, however, Tedeschi, Cann, Taku, Senol-Durak, and Calhoun (2017) have recently, in an attempt to capture more broadly survivors' experiences of existential (not only spiritual) change, published an expanded version of the PTGI (i.e. PTGI-X). Using this latest version of the PTGI in future studies could give us a better understanding of trauma survivors' existential changes, particularly in more secular countries.

In line with Tedeschi and Calhoun's PTG model, and previous empirical results (Blix et al., 2013; Kleim & Ehlers, 2009; Kunst, 2010), we found a positive and significant relationship between peritraumatic reactions and subsequent PTG. Furthermore, in line with findings from several cross-sectional studies (e.g. Allbaugh et al., 2015; Kuenemund et al., 2016; Roland et al., 2013), we found a positive association between event centrality and PTG. These findings suggest that both peritraumatic reactions and perceptions of centrality may help explain individual differences in trauma survivors' level of self-reported growth. However, importantly, we did not find support

for the hypothesis that survivors' perception of event centrality significantly mediates the association between peritraumatic reactions and later self-reported PTG.

As previously described, the longitudinal association between centrality and PTG has been explored in two studies to date, and while Staugaard et al. (2015) (who measured event centrality during deployment and PTG 2–4 months later) found that centrality prospectively predicted PTG, Blix et al. (2015) did not find a causal longitudinal association between the constructs (measured 10 months, and two years post-trauma). In light of these findings, it is possible that perception of centrality is crucial in the initial development of PTG, but that it is less important in explaining how PTG develops over time, as also suggested by Blix et al. (2015). Given that our data collection on event centrality was commenced over one year post-trauma, we could not explore potential earlier effects of centrality on the development of PTG. A relevant question here, however, is how early event centrality can be meaningfully measured. More specifically, how soon after a traumatic experience will survivors be able to consider the extent to which the event has become a turning point in their life story; a central component of their identity; and a reference point for their everyday inferences? We believe that at least some cognitive processing must take place before trauma exposed individuals will consider the event to have become highly influential to his or her identity formation. Alternatively, it is possible that the type of centrality people report on differs depending on the amount of time that has passed since the event. That is, if survivors are asked during, or shortly after, a traumatic event, they are in fact, in our opinion, reporting on their *expectations* of how central the event will be for them. This can be termed 'anticipated centrality', and may differ importantly from their 'retrospectively evaluated centrality', that is, perceived centrality reported months, or even years, post-trauma. In short, given that Staugaard et al. (2015) found that centrality measured during deployment predicted later growth, we may hypothesize that trauma survivors' anticipated centrality is more strongly related to the PTG process than their retrospectively evaluated centrality. On the other hand, importantly, because Staugaard et al. (2015) only measured PTG at follow-up, they could not control for PTG at baseline in their regression analysis. Blix et al. (2015), who did measure both constructs at both time-points, did not find any cross-lagged association between them. As such, it is possible that these constructs are not longitudinally related when initial levels are controlled for, but more research is warranted.

Finally, because few longitudinal studies on trauma survivors` perceived event centrality and growth exist to date, we do not know the degree to which these posttraumatic reactions change over time. Nevertheless, to the extent that perceived centrality actually is a key factor in the development of PTG (as recently put forward by Tedeschi et al., 2018), it is reasonable to assume that these changes should go in the expected direction (i.e. that high centrality predicts later growth). Importantly, however, as noted by Epskamp et al. (2018), when studying the longitudinal relationship between variables, 'the optimal lag interval is often unknown and can even differ between individuals and notably also for different variables' (p. 7). In the present study, the time-lag between measurements was approximately one year. It is possible that the mediating association between perceived centrality and growth is better characterized by short-term effects not captured by the present design. To explore this further, longitudinal studies with shorter time lags are needed.

4.1. Study strengths and limitations

In the present study, participants were asked to report their positive post-trauma changes about 2.5 years after the attack. To the extent that PTG is a process that takes time, as suggested by Helgeson et al. (2006), this may be considered a study strength, because it gave the survivors time to appraise how the terrorist attack had affected them in their everyday life. Because few researchers to date have empirically investigated the cognitive process leading to PTG, our exploration of whether perceived event centrality mediates the association between peritraumatic reactions and later growth in a highly exposed group of young adults post-terror, is an important contribution to the field. Other study strengths include the longitudinal design (which allowed us to test the hypothesized mechanism); state-of-the art mediation analyses; a relatively high response rate; and low levels of missing data.

The above strengths notwithstanding, the present study has several limitations that should be considered when interpreting the results. First, the internal consistency for the peritraumatic reactions measure was relatively low. As such, it is possible that the association between the survivors' reactions during the attack and later perceived PTG/event centrality would have been stronger, had our measure been more consistent. Also, because the survivors' reactions were measured 4–5 months post-trauma, they may have been affected by recollection bias. Second, findings from the sensitivity analysis imply that the estimate of the mediated effect of centrality has low robustness. Third, as noted by Frazier et al. (2009), filling out the PTGI is a demanding task: The participants have to remember how they were before the terrorist attack (about 2.5 years ago); retrospectively compare this to their present self; judge whether they had changed, and if so whether these changes could be attributed to their struggle with their reactions to the terrorist attack. Given the participants' developmental stage (i.e. mainly youth and young adults), this task may have been particularly difficult. The participants' age may

also raise the question of whether their perceived positive changes were catalysed by the trauma and its aftermath; or simply were the result of a natural maturation processes. While this is a relevant concern, existing findings suggest that PTG can be distinguished from normative maturation (see Alisic, Van Der Schoot, Van Ginkel, & Kleber, 2008; Kilmer et al., 2014; Taku, Kilmer, Cann, Tedeschi, & Calhoun, 2012). Furthermore, the fact that their caregivers have reported observing positive changes post-terror (Glad et al., 2019) adds support to the validity of the survivors' self-reported transformation. Finally, the nature of the traumatic event the study participants had been exposed to (i.e. significant life-threat via a single, human-made trauma; geographically constricted to a small island, followed by intense media attention), and the fact that they were a group before the attack (i.e. 82% were members of the Norwegian Labour Party's youth organization), may impede the generalizability of the findings.

4.2. Implications and future directions

The study findings suggest that perceptions of positive personal transformation is prevalent among young terrorist attack survivors, particularly greater personal strength and a new appreciation of life. Importantly, however, we did not ask the participants to specify the time-frame for these changes. As such, we do not know if they experienced them soon after the event or more recently, nor whether they were experienced as temporary or enduring. These aspects of PTG are important areas for future research. Also, given the sparse studies, and mixed findings, on the longitudinal relationship between event centrality and PTG, and our hypothesis that anticipated centrality may be more strongly associated with the PTG process than retrospectively evaluated centrality, more longitudinal studies, with earlier data collections, are warranted.

Acknowledgments

We sincerely thank everyone who participated in this study. This effort was made possible through the support of the Norwegian Extra Foundation for Health and Rehabilitation and the Norwegian Council for Mental Health, for which the authors express their gratitude. We also thank Ines Blix and Marianne Skogbrott Birkeland who provided important input on the statistical analysis, and Michael Daly for important input on the manuscript.

Disclosure statement

No potential conflict of interest was reported by the authors.

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