Cognitive flexibility and attentional patterns among trauma survivors: preliminary evidence from an eye-tracking study

Wivine Blekic, Nellia Bellaerta, Nicolas Lecomte, Kendra Kandana Arachchige, Hadrien Melot, and Mandy Rossignol

ABSTRACT
Background: Executive functioning has been linked to both the development of post-traumatic symptoms and the efficiency of therapy. Specifically, flexibility processes seem to play a major role in the use of efficient coping strategies after a traumatic event. However, only a few studies have focused on the links between flexibility, resilience, and concrete behaviours displayed by individuals.

Objective: The aim of this study was to investigate the influence of emotional content on the efficiency of cognitive flexibility among trauma-exposed individuals.

Method: Twenty-eight trauma-exposed (TE) and 27 non-trauma-exposed (NTE) individuals performed an overlap task in which neutral, positive, and negative pictures appeared in the centre of the screen. Participants were required to disengage their attentional focus from this picture to identify a peripheral target. Analyses included eye movements during the presentation of the scenes and the response times associated with target localization.

Results: TE individuals initially presented a rapid overt disengagement from both neutral and negative emotional information. In other words, TE participants moved their gaze away from the central picture towards the target more rapidly than NTE participants. However, TE participants then displayed longer reaction times to identify the target in comparison with NTE participants.

Discussion: This study presents preliminary evidence that cognitive flexibility may be relevant when considering the impact of trauma. The developed task could provide a novel way to assess this flexibility within an emotional context.

LETTER TO THE EDITOR

Cognitive flexibility and attentional patterns among trauma survivors: preliminary evidence from an eye-tracking study

Wivine Blekic, Nellia Bellaerta, Nicolas Lecomte, Kendra Kandana Arachchige, Hadrien Melot, and Mandy Rossignol

© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (http://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.
1. Introduction

Around 70% of the population will experience at least one traumatic experience in their life and become at risk for developing negative mental health outcomes (Kessler et al., 2017). Executive functioning is a noteworthy target of research considering that it has been linked to both the development of post-traumatic stress disorder (PTSD) and the efficiency of therapy (Samuelson et al., 2020). However, only a handful of studies have assessed executive processes in traumatized patients. Therefore, the overlap task would be a worthwhile paradigm to consider. This task requires an active disengagement from the central stimulus, therefore relying on cognitive flexibility (Dajani & Uddin, 2015). The concept of cognitive flexibility is complex and involves several neurocognitive processes, including attention, task switching, executive functions, and inhibition. The overlap task has been shown to measure these flexibility processes (Bar-Haim, Lamy, & Glickman, 2005). To the best of our knowledge, the overlap task has not been specifically used to assess these processes in traumatized patients. In addition, the use of eye-tracking technology constitutes an interesting method to investigate the time course of attentional deployment during this task (Gaspenin, Leonard, & Luck, 2017). However, eye-tracking studies in the field of PTSD are still limited (Blekic et al., 2021; Lazarev et al., 2021). Therefore, the purpose of this study was to investigate the cognitive flexibility underlying attentional processes within an emotional context among individuals who have encountered a trauma in the past but did not develop PTSD, using an overlap task and an eye-tracking device.

2. Method

2.1. Population

Individuals were invited to participate in the study via a social media campaign (Facebook adverts, Twitter and Facebook posts, and emails to university members with a request to forward it to whomsoever it may concern). The questionnaire was administered using online survey methods, via the LimeSurvey platform, and aimed to attest the presence of trauma exposure (criterion A) and PTSD symptomatology, using the extended Post-Traumatic Symptoms Checklist for DSM-5 and criterion A assessment (PCL-5) (Weathers et al., 2013). This assessment of criterion A allowed us to evaluate the presence of a traumatic event as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (American Psychiatric Association, 2013). A total of 130 participants fully completed the questionnaire. Two clinician psychologists reviewed the PCL-5 answers and excluded participants for whom the presence or absence of criterion A was up for debate (n = 8). The total score on the PCL-5 was used to estimate symptom severity and was below the PTSD threshold of 33 in both groups (15 participants were removed owing to high PCL-5 scores). The 107 remaining participants were contacted, and 68 agreed to take part in the following study. The mean age of the total sample was 29.49 years. This sample was composed of individuals without a high-school degree (2%), with a high-school degree (42%), a bachelor’s degree (43%), and a master’s degree (13%). The trauma-exposed (TE) group consisted of 28 participants (nine men, 19 women, mean age = 28.48 years, SD = 9.42) who had encountered a traumatic experience in the past. Twenty-seven non-trauma-exposed (NTE) participants did not report such a history of trauma (13 men, 25 women, mean age = 30.57 years, SD = 13.74). The groups did not differ regarding gender (χ² = 1.34, p = .24) or educational level (F = 0.186, p = .67). Exclusion criteria included substance abuse in the past year, use of psychotropic medications within 4 weeks, history of psychosis, general anxiety disorder, attention deficit disorder, or learning disability, neurological illness, and/or head trauma.

2.2. Procedure

Participants received an information letter and signed an informed consent form before starting the experiment. During the face-to-face session, the French
adaptations of several questionnaires were administered. First, the Attentional Control Scale (ACS) (Blekic et al., 2019) was used to assess the control of attentional resources. This scale consists of 20 self-reported items rated from 1 to 4 (1 = almost not true/untrue to 4 = always true). Participants had to judge how often, or how much, each statement applied to them. The Cronbach’s alpha in our sample was 0.77. Secondly, the Connor–Davidson Resilience Scale (CDR) (Guihard et al., 2018; Hébert et al., 2018) was used to assess the skills required to adapt to aversive situations. Participants completed the 10-item version, in which each item is rated on a five-point rating scale (0 = not true at all to 4 = true most of the time). The Cronbach’s alpha was 0.68. Thirdly, the Acceptance and Action Questionnaire-II (AAQ-II) (Bond et al., 2011) was used to assess psychological inflexibility. The AAQ-II is a seven-item self-report measure that uses a seven-point Likert scale (1 = never true, 7 = always true). The Cronbach’s alpha was 0.91.

2.3. Overlap task

Participants were seated 54 cm away from a computer screen, this distance being used to calculate visual angles. An HP computer with SMI iView 250 RED and SMI Experiment Suite 360 software was used to generate the protocol on a 34 × 19 cm LCD screen running at a frame rate of 120 Hz. A visual description of the task is presented in Figure 1. Each trial started with a fixation stimulus (i.e. a 1.5° × 0.5° black cross) of 1500 ms. This cross was replaced by a picture (neutral, negative, or positive) of 7.9° × 6.3°. The pictures (N = 20 for each valence) were taken from two databases (Blekic et al., 2021; Bradley & Lang, 2007), and were presented for 500 ms, after which a black outline shape target appeared. The shape was either a square or a diamond (i.e. an identical square rotated by 90°), subtending 1.6° × 1.6°. This target appeared at one of four possible locations at 19.6° from the picture. Triggered areas of interest were located on the target (square or diamond) with a time delay of 100 ms. This means that participants were held on this screen until a fixation of 100 ms on the target was made. This would ensure that the participant made a saccade towards the target. Participants were asked to identify the target, as fast as possible, using the keyboard. Reaction times were recorded from the moment the target disappeared. The experiment included 240 trials (each picture being repeated four times) and took approximately 13 min to complete.

2.4. Data analysis

The statistical analyses were computed using the software R studio version 1.2.1335 (RStudio, Inc.) and statistical significance was accepted at a Bonferroni-adjusted alpha level of 0.016 (p = .05/3). We performed two repeated-measure analyses of variance (ANOVs) on both reaction times and eye-tracking measures (latencies to fixate the peripheral target), with emotion (neutral, positive, and negative) as a within-subject factor and group as a between-subject factor. To minimize type I errors, the Greenhouse–Geisser correction was applied. A multiple linear regression was performed to test whether some variables of interest could predict either reaction time or

---

**Table 1. Clinical characteristics of the sample.**

|                      | TE (n = 28) | M   | SD  | NTE (n = 27) | M   | SD  | F    | p    |
|----------------------|------------|-----|-----|--------------|-----|-----|------|------|
| Attentional control  | 48.43      | 8.51| 47.15| 6.74         | 0.38| 0.38| .54  |
| Psychological inflexibility | 23.36 | 10.36| 22.22| 8.24         | 0.20| 0.06|      |
| Resilience abilities | 25.86      | 5.02| 27.22| 4.66         | 1.08| .30 |      |
| PTSD symptoms        | 16.33      | 16.87| 20.00| 13.71        | 0.77| .38 |      |

TE, trauma-exposed; NTE, non-trauma-exposed; PTSD, post-traumatic stress disorder.
fixation latencies, using clinical characteristics as predictors.

3. Results

3.1. Demographics

Demographic and clinical characteristics of the study groups are shown in Table 1. Among the TE individuals, 35.7% reported being victims of interpersonal violence, 35.7% reported having brutally lost a close relative or friend (through an unexpected accident or suicide), 21.4% reported having witnessed or learned about a serious accident (e.g. a car accident or injury needing immediate assistance), and 10.7% were not willing to report details about their trauma. On average, the incident occurred 9 years ago (with a range between 5 months and 28 years).

3.2. Reaction times

A main effect of group was highlighted \( F(1,59) = 9.86, p = .0008 \), showing slower reaction times to identify targets by the TE participants \( M = 310.28, SD = 64.27 \) compared to the NTE participants \( M = 231.39, SD = 84.57 \). However, no effect of emotion was found \( F(1,46) = 7.59, p = .008 \). The regression analyses did not highlight any significant influence of clinical characteristics on reaction times.

3.3. Eye-gaze data

The time needed to fixate the peripheral target did not differ between groups \( F(1,53) = 1.82, p = .18 \) or emotions \( F(2,93) = 0.72, p = .47 \). Nevertheless, a group * emotion interaction was found \( F(2,93) = 5.26, p = .009 \). We investigated this interaction using paired \( t \)-tests, which revealed that TE individuals detected cues following negative \( M = 467.58 \) ms, \( SD = 47.07, t(25) = -2.79, p = .010 \)) and neutral \( M = 470.08 \) ms, \( SD = 50.01, t(25) = -3.46, p = .002 \)) pictures more rapidly than cues following positive pictures \( M = 485.61 \) ms, \( SD = 52.95 \). The regression analyses did not highlight any significant influence of clinical characteristics on these latencies.

4. Discussion

The present study aimed to investigate the cognitive flexibility underlying attentional pattern(s) among individuals who have encountered a trauma in the past but did not develop PTSD. Using an overlap task, we assessed, through behavioural and eye-tracking measures, the ability to disengage from a central emotional information in order to correctly perform a neutral task.

The main finding of this study was the opposite pattern of motor and attentional processes in trauma survivors. Eye-tracking analyses highlighted that participants first presented a rapid overt disengagement from both neutral and negative emotional information (i.e. preserved cognitive flexibility abilities, as indexed by saccadic movements), followed by a longer time needed to identify the target (as indexed by reaction-time data). The same pattern was found by Sagliano, Trojano, Amoriello, Migliozzi, and D’Olimpio (2014) when examining the timing of attentional biases in non-clinical high trait anxiety and low trait anxiety individuals.

These results should be considered as preliminary. Several limitations justify the caution required when interpreting the results, such as the small sample size, the heterogeneity of the reported trauma types, and the low alpha score of the resilience scale. Nevertheless, considering the different patterns (both behavioural and gaze-related) shown by the TE group, our results indicate that cognitive flexibility processes should be considered when studying the impact of trauma.

Overall, this study highlighted that TE individuals performed differently from NTE individuals in our overlap task. Therefore, it provides preliminary evidence that cognitive flexibility could be taken into account when considering the impact of trauma exposure, and that the current task may be suitable for assessing this cognitive flexibility. The use of this task among a larger sample could allow further interpretation of these results.

Data availability statement

The data that support the findings, along with the R script depicting statistical analyses of this study, are available online at: https://osf.io/ehc8b/?view_only=fa4da7d1536748428813d144dc9b7c8e

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

Wivine Blekić was funded by the Fonds De La Recherche Scientifique - FNRS (Brussels, Belgium) [grant number F6/40/5] and an additional grant from the Complexys Institute (University of Mons). Those funding sources did not exert any influence or censorship on the present work.

Open Scholarship

This article has earned the Center for Open Science badge for Open Data. The data are openly accessible at https://doi.org/10.34691/FK2/ULMNHV.
References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Bar-Haim, Y., Lamy, D., & Glickman, S. (2005). Attentional bias in anxiety: A behavioral and ERP study. Brain and Cognition, 59(1), 11–22. doi:10.1016/j.bandc.2005.03.005

Blekic, W., Kandana Arachchige, K., Wauthia, E., Simoes Loureiro, I., Lefebvre, L., & Rossignol, M. (2021). Affective ratings of pictures related to interpersonal situations. Frontiers in Psychology, 12, 627849. doi:10.3389/fpsyg.2021.627849

Blekic, W., Wauthia, E., Kornacka, M., Kandana Arachchige, K., Lefebvre, L., & Rossignol, M. (2021). Eye-tracking exploration of inhibitory control in post-traumatic stress disorder: An emotional antisaccade paradigm. European Journal of Psychotraumatology, 12(1), 1909281. doi:10.1080/20008198.2021.1909281

Blekic, W., Wauthia, E., Simoes Loureiro, I., Kandana Arachchige, K., Lefebvre, L., & Rossignol, M. (2019). Étude factorielle exploratoire de la version française de l’Échelle de Contrôle Attentionnel: Liens avec les symptômes d’anxiété et de dépression. Revue Francophone de Clinique Comportementale et Cognitive, 24(3), 13–22.

Bond, F. W., Hayes, S. C., Baer, R. A., Carpenter, K. M., Guenole, N., Orcutt, H. K., … Zettle, R. D. (2011). Preliminary psychometric properties of the acceptance and action questionnaire–II: A revised measure of psychological inflexibility and experiential avoidance. Behavior Therapy, 42(4), 676–688. doi:10.1016/j.beth.2011.03.007

Bradley, M. M., & Lang, P. J. (2007). The International Affective Picture System (IAPS) in the study of emotion and attention. In J. A. Coan & J. J. B. Allen (Eds.), Handbook of emotion elicitation and assessment (pp. 29–46). New York: Oxford University Press.

Dajani, D. R., & Uddin, L. Q. (2015). Demystifying cognitive flexibility: Implications for clinical and developmental neuroscience. Trends in Neurosciences, 38(9), 571–578. doi:10.1016/j.tins.2015.07.003

Gaspeni, N., Leonard, C. J., & Luck, S. J. (2017). Suppression of overt attentional capture by salient-but-irrelevant color singletons. Attention, Perception, & Psychophysics, 79(1), 45–62. doi:10.3758/s13414-016-1209-1

Guihard, G., Deumier, L., Aliot-Licht, B., Bouton-Kelly, L., Michaut, C., & Quilliot, F. (2018). Psychometric validation of the French version of the Connor-Davidson Resilience Scale. L’Encéphale, 44(1), 40–45. doi:10.1016/j.encep.2017.06.002

Hébert, M., Parent, N., Simard, C., & Laverdière, A. (2018). Validation of the French Canadian version of the brief Connor–Davidson Resilience Scale (CD-RISC 10). Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement, 50(1), 9.

Kessler, R. C., Aguilar-Gaxiola, S., Alonso, J., Benjet, C., Bromet, E. J., Cardoso, G., … Koenen, K. C. (2017). Trauma and PTSD in the WHO world mental health surveys. European Journal of Psychotraumatology, 8(sup5), 1353383. doi:10.1080/20008198.2017.1353383

Lazarov, A., Suarez-Jimenez, B., Zhu, X., Pine, D. S., Bar-Haim, Y., & Neria, Y. (2021). Attention allocation in posttraumatic stress disorder: An eye-tracking study. Psychological Medicine, 1–10. doi:10.1017/S0033291721000581

Sagliano, L., Trojano, L., Amoriello, K., Migliozzi, M., & D’Olimpio, F. (2014). Attentional biases toward threat: The concomitant presence of difficulty of disengagement and attentional avoidance in low trait anxious individuals. Frontiers in Psychology, 5, 685. doi:10.3389/fpsyg.2014.00685

Samuelson, K. W., Newman, J., Abu Amara, D., Qian, M., Li, M., Schultebraucks, K., … Marmar, C. R. (2020). Predeployment neurocognitive functioning predicts post-deployment posttraumatic stress in Army personnel. Neuropsychology, 34(3), 276–287. doi:10.1037/neu0000603

Weathers, F. W., Litz, B. T., Keane, T. M., Palmieri, P. A., Marx, P. B., & Schnurr, P. P. (2013). The PTSD Checklist for DSM-5 (PCL-5) – Extended Criterion A [Measurement instrument]. https://www ptsd.va.gov/