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LETTER TO THE EDITOR

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

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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.

Flexibilidad cognitiva y patrones atencionales entre sobrevivientes de trauma. Evidencia preliminar de un estudio de seguimiento ocular

Antecedentes: El funcionamiento ejecutivo se ha relacionado tanto con el desarrollo de síntomas postraumáticos como con la eficiencia de la terapia. Específicamente, los procesos de flexibilidad parecen jugar un papel importante en el uso de estrategias de afrontamiento después de un evento traumático. Sin embargo, solo unos pocos estudios se han centrado en los vínculos entre la flexibilidad, la resiliencia y los comportamientos concretos que muestran los individuos.

Objetivo: El objetivo de este estudio fue investigar la influencia del contenido emocional en la eficiencia de la flexibilidad cognitiva entre individuos expuestos a traumas.

Método: 28 personas expuestas a trauma (ET) y 27 no expuestas a trauma (NET) realizaron una tarea superpuesta en la que aparecían imágenes neutras, positivas y negativas en el centro de la pantalla. Se pidió a los participantes que desvincularan su foco de atención de esta imagen para identificar un objetivo periférico. Los análisis incluyeron movimientos oculares durante la presentación de las escenas y los tiempos de respuesta asociados con la localización del objetivo.

Resultados: Los individuos con ET inicialmente presentaron una desconexión abierta y rápida de la información emocional tanto neutral como negativa. En otras palabras, los participantes con ET alejaron su mirada de la imagen central hacia el objetivo más rápido que los participantes NET. Sin embargo, los participantes con ET mostraron tiempos de reacción más largos para identificar el objetivo en comparación con los participantes NET.

Discusión: Los individuos con ET inicialmente presentaron una desconexión abierta y rápida de la información emocional tanto neutral como negativa. En otras palabras, los participantes con ET alejaron su mirada de la imagen central hacia el objetivo más rápido que los participantes NET. Sin embargo, los participantes con ET mostraron tiempos de reacción más largos para identificar el objetivo en comparación con los participantes NET.

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Flexibilidad; trauma; seguimiento ocular; atención; procesos ejecutivos; resiliencia; TEPT

关键词
灵活性; 创伤; 眼动追踪; 注意力; 执行加工; 心理韧性; PTSD

HIGHLIGHTS

- This study developed an original assessment of cognitive flexibility processes in an emotional context.
- Cognitive flexibility was assessed using an overlap task and eye-tracking technology.
- Cognitive flexibility may be relevant when considering the impact of a trauma.

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创伤幸存者的认知灵活性和注意模式：眼动追踪研究的初步证据

背景：执行功能与创伤后症状 的发展和治疗效率有关。具体而言，灵活性加工似乎在创伤事件后使用有效的应对策略中发挥了重要作用。然而，只有少数研究关注灵活性、心理韧性和个人表现出的具体行为之间的联系。
目的：本研究旨在考查情绪内容对创伤暴露个体认知灵活性效率的影响。
方法：28 名创伤暴露 (TE) 和 27 名非创伤暴露 (NTE) 个体执行了一项中性、正面和负面图片出现在屏幕中央的重叠任务。参与者被要求将注意力从这张图片中分离出来，以识别外围目标。分析包括场景呈现期间的眼运以及与目标定位相关的反应时。
结果：TE 个体最初表现出对中性和负面情绪信息的快速公开脱离。换句话说，TE 参与者的视线从中心图片移向目标的速度比 NTE 参与者快。然而，与 NTE 参与者相比，TE 参与者表现出更长的反应时间来识别目标。
讨论：本研究提供的初步证据表明，在考虑创伤影响时，认知灵活性可能是相关的。成熟的任务可能提供一种在情感环境中评估这种灵活性的新方法。

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 (Gaspelin, Leonard, & Luck, 2017). However, eye-tracking studies in the field of PTSD are still limited (Blekic et al., 2021; Lazarov 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 ($\chi^2 = 1.34$, $p = .24$) 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

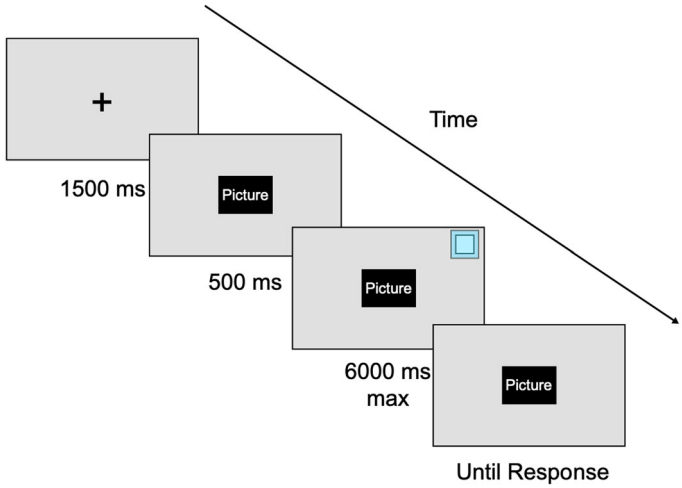

Figure 1. Description of the task. The triggered area of interest was not seen by the participant but is represented here by a blue square as an example. The reaction times were recorded from the moment the target disappeared (last slide).

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 (Blekić 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.

Table 1. Clinical characteristics of the sample.

	TE ($n = 28$)		NTE ($n = 27$)			
	M	SD	*M*	SD	*F*	*p*
Attentional control	48.43	8.51	47.15	6.74	0.38	.54
Psychological inflexibility	23.36	10.36	22.22	8.24	0.20	.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.

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 (ANOVAs) 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

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 a 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.

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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.

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