



Emotional Stroop interference in trauma-exposed individuals: A contrast between two accounts



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ABSTRACT

In the Emotional Stroop task, trauma-exposed victims are slowed when naming the colour print of trauma-related words, showing the presence of interference. This interference has been assumed to reflect emotional reactions triggered by experience-relevant emotional content which interfere with the task. However, it may equally reflect the activation of task-competing thoughts triggered by experience-relevant semantic content, thus resulting from cognitive- rather than emotion-driven processes. This study contrasted these possibilities by measuring the relationship between Emotional Stroop interference, on the one hand, and severity of sexual-abuse experience, subjective ratings of emotionality, and working-memory measures, on the other. Whereas there was no relationship between working-memory measures and interference, providing no support for the cognitive-based account, experience severity, emotionality ratings and abuse-related interference were all positively related, providing support for the emotion-based account. These findings support the idea that the Emotional Stroop task can be used as a diagnostic tool for emotion-filtering impairment.

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1. Introduction

Traumatic experiences are common with a lifetime prevalence rate of more than 60% in the general population (e.g., Resnick, Kilpatrick, Dansky, Saunders, & Best, 1993). People subject to traumatic experiences, such as sexual abuse, are exposed to intense emotions and this has cognitive consequences not only during the traumatic experience but also long after it, notably on short-term verbal memory, working memory and sustained attention (Jenkins, Langlais, Delis, & Cohen, 1998; Navalta, Polcari, Webster, Boghossian, & Teicher, 2006; Stein, Hanna, Vaerum, & Koverola, 1999; Stein, Kennedy, & Twamley, 2002). Importantly, trauma-exposed victims present a long-term alteration of selective attention characterised by an impaired attentional filtering for trauma-related emotional information (Cisler et al., 2011; Williams, Mathews, & MacLeod, 1996). A good understanding of the effect of trauma on attention is important, not least because this effect might play a role in the causation and maintenance of trauma-related psychopathologies such as anxiety and posttraumatic stress disorder (PTSD; Williams et al., 1996). Thus far, however, this effect has been studied mostly using the Emotional Stroop task (Ray, 1979), a task that remains controversial with regard to the processes it indexes. Specifically, the Emotional Stroop task might index general cognitive effects, such as semantic interference, rather than emotion-specific effects as classically assumed (Becker, Rinck, Margraf, & Roth, 2001; Williams et al., 1996). The present study aimed to shed

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new light on this issue. It contrasted and tested two accounts, one emotional and one cognitive, for the impact of trauma on attention as observed with the Emotional Stroop task.

The Emotional Stroop task was designed by analogy to the Cognitive Stroop task (Stroop, 1935). In the Cognitive Stroop task, participants are asked to name the colour print of a word; reaction times (RTs) are slowed when colour print and semantic meaning of a colour word are inconsistent (e.g., the word 'green' presented in red). The extent to which participants are slowed by inconsistent semantic information, compared to neutral semantic information, provides an index of participant's attentional inefficiency, that is, their difficulty in focusing on the primary colour-naming task and ignoring task-unrelated distracting stimuli. The Emotional Stroop task is similar to the Cognitive Stroop task except that it uses emotional words instead of colour words. In the Emotional Stroop task, participants are slower when they name the colour of an emotional word compared to when they name the colour of a neutral word (Ray, 1979). The amount of interference, namely, the extent to which participants are slowed by emotional semantic information, provides an index of participant's difficulty in ignoring task-unrelated emotional content. A crucial aspect of this task is that the effect of emotional words largely depends on experience: the more an emotional word is relevant to the personal experience of an individual, the stronger its effect on this individual. For instance, while sexual-abuse words produce strong interference for rape victims (e.g., Cassidy, McNally, & Zeitlin, 1992) and war-related words exert strong influence in Vietnam-war veterans (e.g., Litz et al., 1996), the same words exert little interference in controls.

The effect of emotional words in the Emotional Stroop task is believed to reflect a failure of selective attention to filter out experience-relevant emotional content. The exact processes involved however remain disputed despite over thirty years of research using the task (Becker et al., 2001; Gilboa-Schechtman, Revelle, & Gotlib, 2000; Williams et al., 1996). On the one hand, experience-relevant emotional words might exert their impact through their high emotional salience (e.g., their threat value), suggesting that attention is affected by the emotional reactions triggered by semantic content. On the other hand, experience-relevant emotional words might exert their impact through their high conceptual salience (e.g., they match participant's current thoughts), suggesting that attention is affected by interfering thoughts triggered by salient semantic content.

If the Emotional Stroop effect results from conceptual salience, the Emotional Stroop task may not actually index emotional processing. Words relevant to an individual relate to 'current concerns' and might more readily generate task-unrelated thoughts that compete for cognitive resources and slow the primary colour-naming task (Williams et al., 1996). This cognitive account is supported by findings of a large overlap in the brain regions activated by Emotional and Cognitive Stroop tasks (Whalen et al., 1998). It is also supported by findings showing that words that are not emotional can nevertheless generate interference when they match personal interests (Gronau, Cohen, & Ben-Shakhar, 2003). For instance, in one study (Dagleish, 1995), bird names were found to produce interference in ornithologists but not in controls. In sum, the cognitive account suggests that Emotional and Cognitive Stroop tasks tap similar cognitive processes.

Numerous studies have shown that Cognitive Stroop interference is predicted by participants' working-memory efficacy (e.g., Kane & Engle, 2003; Kiefer, Ahlegian, & Spitzer, 2005; Long & Prat, 2002). Differences in the efficiency of two subcomponents of working memory, the central executive and the phonological loop (Baddeley, 2003), are likely to account for interindividual differences in Cognitive Stroop interference. Participants with a less efficient central executive, which is involved in controlling and regulating information (Baddeley, 2003), are less effective at inhibiting task-irrelevant semantic information (Long & Prat, 2002). In addition, participants with a less efficient phonological loop, which is involved in rehearsing processed information and has a limited capacity (Baddeley, 2003), might be more handicapped by the involuntary storage of task-irrelevant semantic information (Saeki, 2007). If the Emotional Stroop effect is in fact a Cognitive Stroop effect, then interindividual differences in Emotional Stroop interference should be predicted by differences in working-memory efficacy, and more specifically by differences in the efficiency of the central-executive subcomponent and/or of the phonological-loop subcomponent. We tested these predictions in the present study. We measured working-memory efficacy using the running-span task (Pollack, Johnson, & Knaff, 1959), a task which allowed us to isolate the respective contribution of central executive and phonological loop (Vieillard & Bougeant, 2005).

In contrast, or in addition, to the cognitive account, a more widely-held view suggests that the Emotional Stroop task measures emotion-driven interference (Ben-Haim, Mama, Icht, & Algom, 2013). Words reminiscent of past emotional experiences are relevant to people's goals, core beliefs or identity and trigger emotional reactions (e.g., increases in arousal levels; Dresler, Mériaux, Heekeren, & Van der Meer, 2009). This idea is compatible with findings that, unlike the Cognitive Stroop task, the Emotional Stroop task modulates brain activity in the amygdala and occipito-temporal areas, regions involved in emotional processing (Compton et al., 2003). However it is impossible to know whether this activation of emotional brain areas is causal or necessary to the resulting interference. If the effect of emotional words relies on emotional rather than cognitive processes, it should bear little relation to differences in working-memory efficacy. Instead, it should be linked to the 'emotionality' of the stimuli used.

Emotionality refers to the emotional impact of a stimulus, regardless of its valence (i.e., both positive and negative stimuli can be highly emotional; Gilboa-Schechtman et al., 2000; Schimmack & Derryberry, 2005). Emotional stimuli have an impact both on individuals' physiological state (e.g., increase in arousal; Lang, Greenwald, Bradley, & Hamm, 1993) and on their subjective state (e.g., mood; Ben-Haim et al., 2013), effects which are intimately related (Greenwald, Cook, & Lang, 1989). Previous findings suggest that emotionality is central to predicting Emotional Stroop interference (e.g., Ben-Haim et al., 2013; Hart, Green, Casp, & Belger, 2010; Salters-Pedneault, Gentes, & Roemer, 2007). Accordingly, some data showed that emotional stimuli, which were more arousing to participants with high than with low state anxiety, also caused more Emotional Stroop interference in participants with high than with low state anxiety (Dresler et al., 2009). In addition, non-words that had been

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