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Review

Cognitive Intervention on the Flashback of Traumatic Event: Based on the Dual Representation Theory of PTSD

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Abstract: Flashback, related to the traumatic event, is a prominent symptom of posttraumatic stress disorder (PTSD). The dual representation theory (DRT) of PTSD emphasizes that the weakened contextual representation (C-rep), the enhanced sensory representation (S-rep) and the loss of connection between C-rep and S-rep play an important role in the formation and retrieval of flashback. DRT proposes that cognitive intervention tasks which inhibit S-rep or enhance C-rep can reduce flashbacks. And many studies have proved this theoretical hypothesis. In the future, simulation intervention studies should continue to strengthen, some clinical application studies should also be appropriately carried out. Besides, future researchers should innovate the ideas of intervention, focus on designing new cognitive intervention tasks.

Keywords: Posttraumatic stress disorder; flashback; the dual representation theory; cognitive intervention

1 Introduction

In recent years, with the increase of sudden catastrophic events, post-psychological assistance has become the focus of social attention. Among them, the prevention and treatment of posttraumatic stress disorder (PTSD) is a major task of post-psychological assistance. PTSD refers to a delayed or long-lasting mental disorder caused by abnormal threatening or catastrophic trauma. Epidemiological surveys showed that the prevalence of PTSD among adults in the United States was 3.5% in a year, and the prevalence in Europe and most Asian, African and Latin American countries was comparatively lower (about 0.5% to 1.0%) [1]. Most patients with PTSD developed symptoms within a month to half a year after the traumatic event, which can be cured in a year or so; a few can survive for many years or resulted in permanent personality changes. PTSD was first discovered in soldiers experiencing traumatic warfare, known as "battle fatigue"; it was later found among those who experienced other traumatic events such as natural disasters, terrorist attacks, traffic accidents, industrial safety incidents, fires, violent incidents, abuse, death of relatives, etc. Experiencers of traumatic events include both witnesses who are directly involved in the threat at the time of the incident (such as survivors of disasters or accidents, victims of violent incidents), and witnesses or bystanders who are not directly involved in the threat concurrently (e.g., those who witnessed disasters or accidents, witnessed the death of their beloved, and those who entered the scene after the incident (such as those involved in disaster or accident rescue), and those who knew afterwards (such as survivors, victims, relatives of the dead, and even a few others hearing the incident through the media).

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) divides the core symptoms of PTSD into four groups: (1) trauma-related re-experiencing, and (2) sustained avoidance of possible stimuli associated with traumatic events, (3) negative changes in cognition and mood, and (4) arousal and response changes [1]. Among them, re-experiencing symptoms play a key role in the formation and development of PTSD. Reducing re-experiencing is one of the main therapeutic goals of PTSD [1–5]. As a typical re-

experience symptom, flashback is the main manifestation of intrusive memory associated with traumatic events [2–6]. The study found that flashback occurred in almost all patients with moderate to severe PTSD [2,3,7]. Therefore, some researchers see flashback as a hallmark of PTSD [2,6].

It is of great clinical significance to explore the mechanism and intervention of flashback. At present, there are many theories explaining invasive memory (including flashback) [8], in which the dual representation theory of PTSD (DRT) of PTSD is quite influential. This article first briefly introduces the characteristics of flashbacks and flashbacks from the perspective of cognitive psychology. And then DRT's explanation of flashback formation and extraction, intervention hypothesis and related intervention research evidence are discussed, thus trying to set out implications for PTSD prevention and research.

2 Flashbacks: Unsolicited Memory Fragments

2.1 Characteristics of Flashbacks

Flashbacks often recur intrusively, involuntarily and uncontrollably, usually triggered by internal and external contextual cues. Patients traverse back to the original traumatic situation, like "time travel", and re-experience the same traumatic events (i.e., revisiting the moment), but lack time and background information [2,3,7,9]. The main content or theme of flashback is a fragment or fragment of a traumatic event [1,9], containing vivid sensory features, also known as intrusive imagery [2,3,5], primarily visual representation [7,9]; but flashbacks have nothing to do with intentional memory of traumatic events [2]. In addition, flashbacks are often accompanied by intense pain, mainly including fear, sadness, anger, helplessness [3,9]; most flashbacks contain peak moments of painful emotions. Also known as "hotspot" [10,11].

2.2 Perspectives of Cognitive Psychology

Flashbacks can be seen as a memory disorder [2,3], including barriers to memory formation and extraction. The cognitive model of PTSD [12] argues that flashback is the perceived content of traumatic events that are not fully elaborated and contextualized. The triggering of flashback is due to traumatic events related or similar stimuli. The perceptual priming of contextual cues is enhanced (i.e., the patient's perception threshold for these cues is reduced and more easily perceived), allowing the patient to experience the original traumatic situation and negative emotions. The "self-memory system model" [13] argues that flashbacks have the lowest conceptual level but the highest specificity (including perceptual details) in autobiographical memory, often elicited by internal and external contextual cues by direct retrieving, which is essentially the intrusion of episodic memory components (i.e., under-processed perceptual content) that lacks a conceptual contextual knowledge framework [14].

3 DRT and Its Intervention Assumption

DRT shares the same understanding of flashback with cognitive approaches described above, but DRT differs from traditional cognitive psychology in that it supports multiple memory systems [2,3]. DRT was originally proposed by Brewin and his colleagues [15,16] and later revised by Brewin et al. based on the neurobiological model of normal memory and mental imagery [3,17,18], focusing on the neural mechanisms of flashback formation and retrieval.

3.1 Flashback Formation and Retrieval

The revised DRT proposes two memory systems that are independent and mutually influential: contextual memory (C-memory) and sensation-based memory (S-memory) (see Tab. 1 [3]).

Table 1: Characteristics of contextual and sensation-based memory

	Contextual memory	Sensation-Based Memory
Type of representation	Contextual representation (C-rep)	Sensation-Based representation (S-rep)
Characteristics of information	structural, abstract,	depictive
Type of retrieval	voluntary or involuntary via language	involuntary, via contextual clues
Pathway of visual processing	Ventral access (mainly including sensory joint areas, hippocampus, hippocampal gyrus)	Dorsal pathway (mainly including early sensory cortex and subcortical region, amygdala, insula)
Scope of information processing	Attentional window	Entire visual field
Viewpoint of information processing	Viewpoint-independent (allocentric or objective-centered)	Viewpoint-dependent (egocentric or viewer-centered)
Supports	Integration with previous knowledge, simulation, communication	Immediate action, autonomic responses

When an event happens, the normal encoding process is that C-rep and S-rep are simultaneously performed and connected to each other. However, high levels of stress (such as traumatic events) impair hippocampal function while enhancing amygdala function [19], leading to pathological coding of traumatic events (i.e., invasive appearance). The specific performance is: S-rep is up-regulated (enhanced), C-rep is down-regulated (weakened), and the two are disconnected.

When an individual intentionally extracts normal visual memory, the visual appearance is driven by C-rep top down under the guidance of the prefrontal cortex, while the reactivation of S-rep is attenuated, and the reactivation of S-rep depends on individual attention and Perceptual details that match the representation. The involuntary flashback of the traumatic event is characterized by a visual representation driven by S-rep bottom up, triggered by contextual cues, and not affected by a weakly activated C-rep.

In summary, DRT insists that the formation and retrieval of flashback is due to the abnormality of information processing and memory extraction of traumatic events, that is, the functional abnormalities of C-rep and S-rep and the loss of the two (see Fig. 1), emphasizing the role of specific processing (i.e., nature of representation) [20].

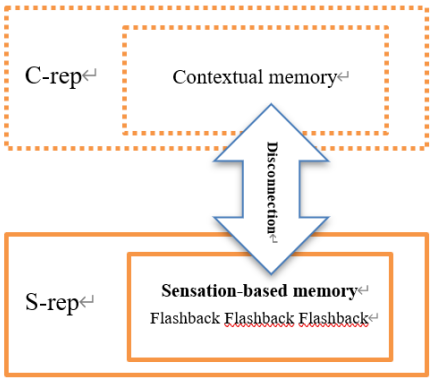

Figure 1: Simplified illustration of DRT

Note: *The solid line indicates enhancement and the dotted line indicates reduction.*

3.2 Flashback Intervention Assumption

According to DRT, the intervention of flashback is mainly to implement cognitive interventions for the two processing paths of the C-rep and S-rep. First, because of the limited cognitive resources of human working memory [21]. Meanwhile, the imagery tasks from different sensory channels can interfere with the corresponding representational processing in working memory and even affect the long-term memory

[22,23].Therefore, in the process of wound information processing and memory re-consolidation, visual resources can be used to compete for visual processing of cognitive resources of the dorsal pathway (i.e., inhibition of S-rep). Thereby reducing flashback. Secondly, it is also possible to enhance the visual processing of the ventral pathway by enhancing the cognitive intervention task of C-rep, and to promote the connection and information integration of C-rep and S-rep, thereby reducing flashbacks.

4 Evidence from Simulation Intervention Studies

Currently, DRT-based intervention studies are mainly to simulate trauma and intervention in healthy subjects. There are many specific practices for simulating trauma [2]. Most of the studies used traumatic films but the contents of films were different, such as those based on real traffic accidents, real emergency scenes, and excerpts of traffic accident film. The lengths of the films were also very different, from only 5 minutes to almost 21.5 minutes. In addition to traumatic films, researchers also used traumatic event reports, photo stories, and emotional pictures to simulate trauma.

4.1 Interventions during Trauma

In the interventions during the trauma period, the experimental group performed the visual space task while receiving the simulated traumatic stimulation, while the control group did not have the task, and finally the flashback diaries within 1 week after the experiment (including the number and frequency of flashbacks) were used to test the effect of the intervention. Visual space tasks used in the study included special keyboard input and plasticine shaping. The former required the subject to quickly and accurately input the letter string specified before the experiment on a 5 × 5 special keyboard (the subject could not see his hand and keyboard), the latter required the tester to make a cube or pyramid quickly and accurately with plasticine (the subjects could not see their hands and plasticine). The study found that the experimental group had fewer flashbacks within one week after the experiment compared to the controlled group [24–31]. However, there is currently no simulated intervention research to enhance C-rep during trauma.

4.2 Post-Traumatic Interventions

The post-traumatic intervention was similar to the intervention during trauma, except that the experimental group performed cognitive intervention tasks after simulated trauma (including visual spatial tasks and cognitive intervention tasks that enhanced C-rep). Cognitive intervention tasks are usually performed within 6 hours of memory consolidation time [32,33]. The visual space tasks include special keyboard input and Tetris games. The C-rep cognitive intervention tasks are mainly memory improvement tasks, including the recognition test for simulated traumatic stimulation and the answers to questions about experimental experience (the thoughts, experiences, etc. in the experiment process). Researchers found that participants who simulated visual space tasks immediately after trauma compared to the control group had fewer flashbacks within 1 week after the experiment [34] while subjects who performed visual space tasks half an hour after the simulated trauma had fewer flashbacks within 1 week after the experiment [34–36]. Even those who simulated visual space tasks after 4 hours of trauma had fewer flashbacks within 1 week after the experiment [36]. Subjects who performed a memory improvement task immediately after the simulated trauma had fewer flashbacks within 1 week after the experiment [37,38]. However, some results showed that no differences were found between the two groups [25,39].

At present, there is no study on simulated intervention for flashback after 6 hours of simulated trauma (i.e., traumatic memory has been consolidated), but research on negative memory representations have found the effective intervention of visual spatial tasks. The study among healthy subjects found that compared with the non-task group, the experimental group kept the negative memory representation and the eye movement, which could reduce the vivid clarity and negative emotion of the negative memory representation [40–44]. The same findings were showed in studies on PTSD patients [45].

The meta-analysis by Lee et al. [46] indicates that effect size of the reduction of vivid and clear negative emotions in the visual representation of the eye movement is moderate in the clinical sample, and the effect size turns to be large in non-clinical samples (especially for the reduction of the vividness of the

representation about negative memory). In addition to eye movements, other visual spatial tasks performed by healthy subjects while they are maintaining a negative memory representation in mind can also reduce the vivid clarity and negative emotions of negative memory representations. Those are tasks like the Tetris game [40] and copying geometry in mind [24]. In addition, cognitive behavioral therapy (CBT) for the PTSD includes traumatic exposure and fine reprocessing of trauma (sufficiently elaborated), while enhancing the avoidance response (reducing negative reinforcement) and C-rep. Many studies among healthy subjects and clinical samples confirm the effectiveness of the therapy [2–5].

5 Evaluation and Outlook

DRT is closely related to the contemporary development of cognitive psychology and neuroscience, and is very beneficial to advance the theoretical and clinical application of flashbacks. Future research may focus on the following areas:

5.1 Simulation Intervention Improving and Clinical Application

Existing studies have shown that the intervention of S-rep-inhibited visual spatial tasks during trauma and within 6 hours after trauma has clearly affected flashbacks, but the effect of C-rep-enhanced cognitive intervention tasks is not clear enough. Therefore, for the intervention of flashbacks, more studies on simulation intervention after the consolidation of traumatic memory should be carried out in the future, and attention should be paid to enhance C-rep during trauma. In addition, for ethics considerations, most of the research is mainly based on simulation studies conducted in healthy subjects, and evidence is lacked for clinical application. It may be considered to appropriately use cognitive intervention tasks (such as special keyboard input and plasticine shaping) with clear simulation intervention effects for clinical application. And gradually intervention research should be carried out in real traumatic situations (such as the comparison of intervention effects of different tasks, comparison of the effects of interventions at different time points after traumatic events, and comparison with trauma patients who did not receive intervention and other groups).

5.2 Focusing on Designing New Cognitive Intervention Tasks

First, the cognitive intervention tasks used in current research aim at experimental manipulation with low ecological validity, and are not suitable for clinical application practices (such as Tetris games). Therefore, for future simulation intervention, we should pay attention to designing more culturally compatible and more life-oriented cognitive intervention tasks (such as planned rosary beads, folding paper cranes), so as to prepare for the clinical applications and real traumatic situation.

Second, most cognitive interventions used in existing studies often are of a single processing pathway (suppressing S-rep or enhancing C-rep) and do not focus on “two-pronged approach” (combining C-rep and S-rep). In fact, based on the current research on embodied cognition, it is found that the intervention of visual space task on flashbacks is not only due to inhibition of S-rep. The study showed that the spatial relationship between human hands and the object affects cognitive processing [47,48], such as the quality of visual perception and attentional bias. Moreover, hand action planning is encoded by visual processing of the dorsal pathway, and decreases the activation of early visual cortex [49–51]. Fine hand movements can improve the temporal and spatial sensitivity of visual processing [52]. Therefore, three kinds of visual space tasks, such as special keyboard input, plasticine shaping, and Tetris game do include hand motion planning and fine hand movements, which compete for the cognitive resources of visual processing of the dorsal pathway (i.e., inhibit S-rep). It also helps to increase the spatiotemporal background information of information processing (i.e., enhanced C-rep). In order to promote clinical research and application of research results in real situations, future research of simulation intervention should focus on designing cognitive intervention tasks that both inhibit S-rep and enhance C-rep.

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