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The influence of contextual threat and safety transmitted by social learning on visual working memory and item/source memory and its modulation by adverse childhood experiences and (social) anxiety

Autor: Sabine Schellhaas
Institut / Klinik: Zentralinstitut für Seelische Gesundheit Mannheim (ZI)
Doktorvater: Prof. Dr. Ch. Schmahl

Recognizing and adequately responding to dynamic environmental conditions is crucial for adaptive and successful behavior. Threatening- and anxiety-inducing situations require well-functioning cognitive, defensive, and neural processes to prevent harm, especially when they are ambiguous. When recognized, threat cues can evoke general arousal and emotions such as fear and corresponding actions can be initiated (e.g., avoidance). The memory-enhancing effects of emotionally arousing stimuli are well documented. Under certain circumstances, the beneficial effect of arousal can spill over from an arousing context to otherwise neutral stimuli and enhance memory of these events. This spillover effect seems to depend on the memory modality and inter-individual differences such as anxiety or chronic stress exposure from childhood trauma, such as adverse childhood experiences (ACE). ACE are often associated with stress and anxiety-related disorders in adulthood. Symptom severity is linked to learning and memory deficits, which could connect childhood maltreatment and psychopathology. How childhood trauma might affect memory distortions in emotionally arousing settings is not well-understood.

The aim of this thesis is to examine the differential effect of threat and safety on neutral face perception, short-term processing (i.e., working memory) and long-term storage (i.e., recognition). Additionally this thesis focuses on the impact of adverse childhood experiences and anxiety on memory processing under threat. Threat was introduced using social fear learning paradigms, increasing the social nature of the tasks and accounting for vicariously and verbally acquired anxiety in psychopathology. Key metrics include measures of recognition and memory performance (Studies 1-3), event-related brain potentials (ERP in EEG; Studies 1 & 2) and measures of the somatic and autonomic nervous systems as indicators of defensive behaviors (startle Electromyography [EMG]; Electrodermal Activity [EDA]; Study 3).

Threat expectation was successfully induced via social learning and was demonstrated in all three studies (verbal threat learning in Study 1-3, observational fear learning in Study 2). This was true for both healthy participants and participants with ACE and varying levels of anxiety, suggesting intact threat learning and perception in trauma-predisposed individuals. Threat-associated faces also led to increased neural processing and psychophysiological responses. This arousal-based attention was evidenced by enhanced early parietal-occipital and late fronto-central negative potentials in EEG as well as threat-potentiated defensive behavior activation (startle reflex EMG, EDA), higher evaluations of perceived threat and arousal and lower evaluation of valence.

During recognition, all participants had difficulty identifying previously seen faces from new faces. They were even less able to recall the associated contexts (Study 1-3). Pro-longing the viewing time during encoding phases, slightly improved person identification (Study 2 & 3). Learning instructions triggered increased recognition of faces from safe contexts in low anxious individuals with ACE (Study 2). In contrast, highly anxious participants seemed to benefit from threatening contexts regarding short-term face processing. Overall, short-term memory was affected neither by ACE nor by differing context conditions, but it was impaired by high cognitive strain. Intriguingly, however, brain activity did differentiate previously seen faces from newly presented pictures (old/new ERP/EEG effect; Study 1 & 2).

Most importantly, we found evidence of a neural differentiation between former threat-associated faces and both safe and new faces (Study 1 & 2). In Study 1, distributed late negativities emerged for threat-

associated faces. This effect was reversed in the ACE sample which exhibited pronounced late positive potential for threat-associated faces relative to safety faces (Study 2). In working memory, more neural processing resources were allocated towards threat especially during high cognitive load conditions (Study 2). These findings support the view that contextually threatening conditions critically modulate face perception even in the absence of conscious recognition. They also point to a decreased capacity for faces when cognitive resources are limited during potentially harmful situations. This could serve as a neural marker for a threat bias in traumatized individuals.

Study 3 showed that conscious memory of faces associated with past dangerous situations appears to be necessary to better prepare individuals for future, and potentially equally threatening encounters. The dissociation in perceptual processing and overt (failed) recognition behavior did not translate into the activation of defensive systems (i.e., startle EMG, EDA) in the absence of actual threat and the associated memory. These findings do not support the notion that perceptual biases and physiological arousal directly relate to threat-associated identity recognition deficits.

Taken together, the three empirical studies included in this thesis show that arousal impeded face identification only when the circumstances of recognizing faces formerly encountered in threat or safety contexts were particularly favorable. Conscious awareness of threat seems required to trigger defensive behavior but not needed to trigger differential neural processing. This suggests that perceptual bias, overt behavior, and cognitive functioning are dissociated. A similar but opposite threat bias was present for healthy individuals and individuals with ACE, indicating an allocation of attention towards arousing stimuli in individuals who experienced childhood trauma. These findings suggest potential for clinical application of reducing threat expectations and inducing safety expectations through social learning. However, future research is needed to disentangle the effects of trauma and anxiety on memory processes.