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Proximity alert! Distance related cuneus activation in military veterans with anger and aggression problems

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ABSTRACT

Problems involving anger and aggression are common after military deployment, and may involve abnormal responses to threat. This study therefore investigated effects on neural activation related to threat and escapability among veterans with deployment experience. Twenty-seven male veterans with anger and aggression problems (Anger group) and 30 Control veterans performed a virtual predator-task during fMRI measurement. In this task, threat and proximity were manipulated. The distance of cues determined their possibility for escape. Cues signaled impending attack by zooming in towards the participant. If Threat cues, but not Safe cues, reached the participants without being halted by a button press, an aversive noise (105 dB scream) was presented. In both the Threat and the Safe condition, closer proximity of the virtual predator resulted in stronger activation in the cuneus in the Anger versus Control group. The results suggest that anger and aggression problems are related to a generalized sensitivity to proximity rather than preparatory processes related to task-contingent aversive stimuli. Anger and aggression problems in natural, dynamically changing environments may be related to an overall heightened vigilance, which is non-adaptively driven by proximity.

1. Introduction

Anger and aggression are feelings and behaviors involving the intent to harm a perceived threat (Anderson and Bushman, 2002). Disproportional anger and impulsive aggression can cause serious problems and danger to the individual and other people. Anger and aggression problems may occur after military deployment (Elbogen et al., 2010; Reijnen et al., 2015) due to the serious impact of a deployment (MacManus et al., 2015). These problems tend to persist over a long period of time, and can develop even after a substantial period of time after deployment (Heesink et al., 2015).

Heightened anger and aggression have been linked to a lowered threshold of perceiving situations as threatening (Novaco and Chemtob, 2002). Animal research shows that distance is an important feature in risk assessment (Blanchard et al., 2011). When a possible threat is observed, a survival mode is activated, involving behavior ranging from freeze or flight when the threat is at a distance, to fight when threat is close by and more imminent (Blanchard et al., 2005). In humans, similar behavior in response to threat has been reported (Blanchard et al., 2001). In threatening situations, humans tend to respond faster (Nieuwenhuys et al., 2012) and show increased response preparation in anticipation of avoidable threat (Gladwin et al., 2016a).

The fight-response in animals is mediated by a neural circuit including the amygdala, the hypothalamus and the periaqueductal gray (PAG; for review see Blanchard et al., 2005). This system appears to be involved with the response to threat in humans as well (Hermans et al., 2013). In fMRI studies using threat paradigms, a shift was found from prefrontal activity during avoidable and distant threat, to brainstem activity (periaqueductal gray; PAG) during unavoidable, proximal threat (Coker-Appiah et al., 2013; Mobbs et al., 2009, 2007). Furthermore, exposure to threat is associated with activation in brain areas implicated in anxiety (Gold et al., 2015).

The Fear-And-Escape Task was developed to investigate the response to threat in interaction with distance (Montoya et al., 2015). The task consists of a virtual predator in which the chance to escape the virtual predator varies with distance: it can be easily escapable, imminent (chance-level escapable) or inescapable. Further, threat is manipulated by using two predators, only one of which is associated with

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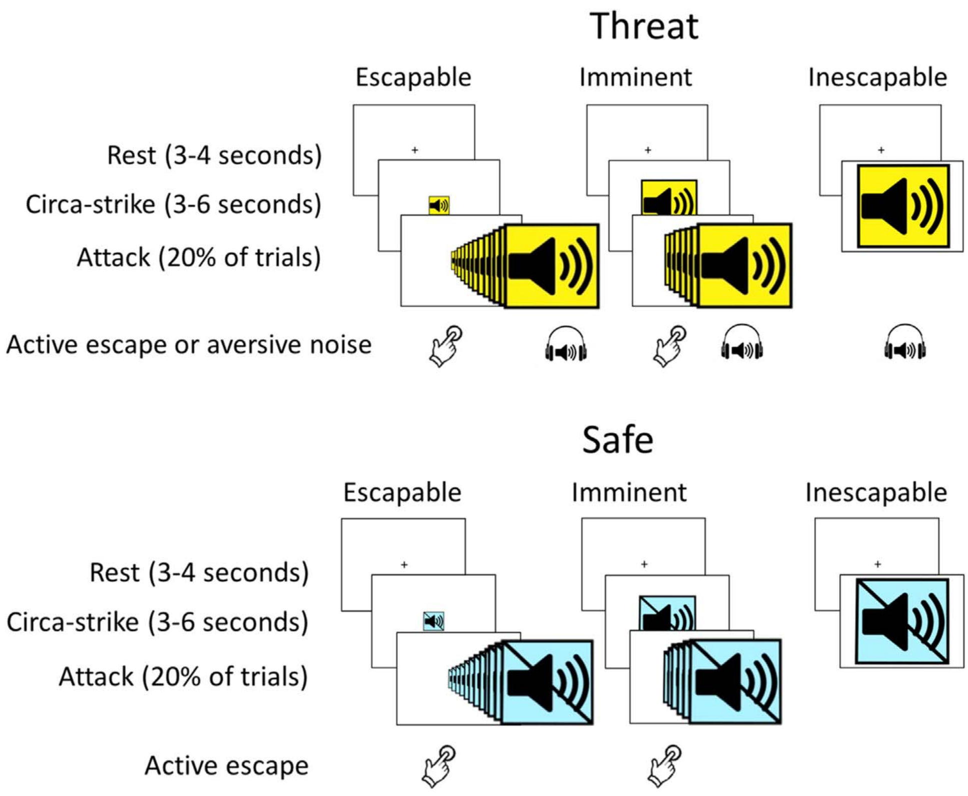

Fig. 1. Outline of the Fear-and-Escape Task (FAET). The task consists of 3 blocks of 29 trials. The Threat condition consists of 5 Escapable trials, 5 Imminent trials and 4 Inescapable trials. In 20% of the Escapable and Imminent (escapable at chance-level) trials the cue attacked the participant by rapidly increasing in size. This could be halted by pushing a button. When this was not done in time, a highly aversive noise was presented. The procedure was exactly the same in the Control condition, only without the threat of the aversive noise.

Table 1
Description of the Anger group and the Control group.

	Anger group (N = 27) Mean (SD)	Control group (N = 30) Mean (SD)	Statistics
Age	36.37 (6.54)	34.53 (7.59)	t (1,55) = 0.97, *ns*
Education	4.22 (0.64)	4.2 (0.81)	t (1,55) = 0.11, *ns*
Number of deployments	2.07 (1.17)	2.37 (1.25)	t (1,55) = −0.91, *ns*
Frequency of aggressive behavior			
Verbal	4.44 (1.55)	0.3 (0.99)	t (1,55) = 12.15, $p < 0.001$
Physical	2.22 (1.65)	0.00 (0.00)	t (1,55) = 7.39, $p < 0.001$
STAXI-2			
State Anger	23.33 (10.08)	15.20 (0.76)	t (1,55) = 4.41, $p < 0.001$
Trait Anger	22.44 (6.88)	12.13 (2.47)	t (1,55) = 7.68, $p < 0.001$
Aggression Questionnaire			
Physical aggression	29.26 (7.10)	18.47 (4.55)	t (1,55) = 6.91, $p < 0.001$
Verbal aggression	15.41 (3.99)	11.3 (1.54)	t (1,55) = 5.23, $p < 0.001$
Anger	24.26 (5.47)	11.17 (2.49)	t (1,55) = 11.83, $p < 0.001$
Hostility	24.04 (7.22)	11.87 (3.41)	t (1,55) = 8.27, $p < 0.001$

Table 2
Behavioral data from the FAET.

Condition	Attempted escapes (SD)		Succeeded escapes (SD)	
	Anger	Control	Anger	Control
Escapable				
Threat	100% (0.0)	100% (0.0)	100% (0.0)	100% (0.0)
Safe	100% (0.0)	100% (0.0)	100% (0.0)	99% (6.1)
Imminent				
Threat	91% (14.9)	87% (20.7)	43% (29.0)	46% (28.3)
Safe	89% (16.0)	89% (16.0)	27% (33.4)	34% (29.7)

Note. Significant differences were found in succeeded escapes in the Imminent Threat condition compared to the Imminent Safe condition (Wilcoxon Signed Rank test, $p < 0.01$). Mann-Whitney U tests revealed no significant differences between the two groups (all p's > 0.234).

an aversive stimulus. The task shows a deactivation of the default mode network (parietal and prefrontal regions) and stronger activation within the midbrain due to threat imminence using a virtual predator (Montoya et al., 2015). This suggests that a shift from planning to impulsive (flight-fight) behavior takes place when threat approaches.

Reactions to threat, such as aggressive behaviors, can be adaptive and result in appropriate defensive responses, but aggression may also be dysfunctional. In individuals with aggression problems, stronger reactivity towards stressful or aversive stimuli has been reported (Patrick, 2008). For instance, individuals scoring high on aggressiveness react to avoidable threat with increased response preparation (Gladwin et al., 2016a). Furthermore, violent behavior in military veterans is associated with hyperarousal symptoms (Taft et al., 2015), also indicating stronger threat reactivity. Aggressive behavior in youths low in psychopathic traits is also linked to exaggerated activity in the PAG (White et al., 2016). In patient populations at risk for impulsive aggression (e.g., Intermittent Explosive Disorder (IED) and borderline personality disorder) heightened amygdala reactivity was found during