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Review article

## Thinking about threats: Memory and prospection in human threat management



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### ARTICLE INFO

#### Article history:

Received 24 February 2016

Revised 10 September 2016

Accepted 22 January 2017

Available online 31 January 2017

#### Keywords:

Episodic foresight

Episodic memory

Semantic memory

Mental time travel

Threat detection

Anxiety

Worry

Evolution

Evolutionary psychology

Counterfactual thinking

### ABSTRACT

Humans have evolved mechanisms for the detection and management of possible threats in order to abate their negative consequences for fitness. Internally generated ('detached') cognition may have evolved in part because of its contributions to this broad function, but important questions remain about its role in threat management. In this article, we therefore present a taxonomy of threat-related internally generated cognition comprising episodic and semantic formats of memory and prospection. We address the proximate mechanisms of each of the capacities in this taxonomy, and discuss their respective contributions to adaptive threat management in humans. For instance, mental time travel empowers people to contemplate and learn from threats experienced long ago, as well as to plan for dangers that might arise in the distant future. However, despite their functional benefits, these thought processes are also central to contemporary anxiety disorders and may be a potent source of distress.

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## 1. Introduction

*Fear keeps pace with hope. Nor does their so moving together surprise me; both belong to a mind in suspense, to a mind in a state of anxiety through looking into the future. Both are mainly due to projecting our thoughts far ahead of us instead of adapting ourselves to the present. Thus it is that foresight, the greatest blessing humanity has been given, is transformed into a curse. Wild animals run from the dangers they actually see, and once they have escaped them worry no more. We however are tormented alike by what is past and what is to come. A number of our blessings do us harm, for memory brings back the agony of fear while foresight brings it on prematurely.*

[Seneca 60AD]

Some capacity for defence in the face of immediate danger is perhaps a universal attribute of all animal species. It has long been recognised that humans, like many other animals, have evolved complex suites of physiological and cognitive processes to detect and manage potential threats to fitness (Cannon, 1916; Darwin, 1872). The distinction between immediately perceptible or *manifest* threats, on the one hand, and *potential* threats on the other has since been used to discern defensive responses to threat in terms of temporal proximity (Blanchard, Griebel, Pobbe, & Blanchard, 2011; Boyer & Lienard, 2006; Eilam, Izhar, & Mort, 2011; Woody & Szechtman, 2011). A loosely conceptualised gradient has therefore been drawn between defensive reactions to immediate threats ('fear') and defensive reactions to potential threats ('anxiety'). In both cases, however, an animal may use cues in the environment to assess the presence of threat, and to thereby launch the appropriate response(s). However, detection and preparation for potential threats can extend, at least in humans, beyond a response tethered to perceptible cues in the environment. A capacity for internally generated thinking enables humans to represent potential future threats (prospectively) or reflect on those that they have already experienced (retrospectively), without having to rely on information available in their immediate surroundings (Pearson, Naselaris, Holmes, & Kosslyn, 2015; Schooler et al., 2011; Suddendorf & Corballis, 2007).

In this paper, we present a taxonomy of threat-related internally generated cognition that comprises episodic and semantic formats of memory and prospection, based on an earlier taxonomy presented by Suddendorf and Corballis (2007). For each of the capacities in this taxonomy, we address both proximate mechanisms (in terms of content and phenomenology, cognitive characteristics, development and underlying neurobiology), as well as ultimate questions (in terms of evolutionary heritage and function). As was recognised by early thinkers in ethology (Mayr, 1961; Tinbergen, 1963), there is utility in embedding mechanistic explanations in their proper evolutionary context (Scott-Phillips, Dickins, & West, 2011). Thus, while Seneca in the opening quote regards threat-related memory and prospection as a curse, we propose that despite their costs for wellbeing, these capacities have characteristics that suggest they have been shaped by natural selection as tools in the struggle for survival and reproduction.

## 2. What are threats?

We here broadly define a threat in evolutionary terms, in line with previous accounts (Gray & McNaughton, 2003; Marks & Nesse, 1994), as any aspect of the environment that could be detrimental to the fitness of the organism. Humans have evolved systems to detect and manage at least certain classes of these threats that have been encountered over many generations in ancestral environments (Beck, Emery, & Greenberg, 1985; Blanchard et al., 2011; Neuberg, Kenrick, & Schaller, 2011; Sherlock, Zietsch, Tybur, & Jern, 2016; Stein & Nesse, 2011; Tooby & Cosmides, 1990). Our forebears were no doubt regularly confronted with many types of potential threats, ranging from the quasi-universal risk of attacks by predators (Barrett, 2005; Hart & Sussman, 2005; Mobbs, Hagan, Dalgleish, Silston, & Prévost, 2015) to more subtle risks such as a loss of social status with potentially severe implications for access to cooperative partners, mates, or resources (Bulley, Miloyan, Brilot, Gullo, & Suddendorf, 2016; Gilbert, 2001; Trower, Gilbert, & Sherling, 1990).

It has been suggested that different, albeit somewhat overlapping, processes have evolved in humans for the detection and management of threats in different domains and under different circumstances (Blanchard, Hynd, Minke, Minemoto, & Blanchard, 2001; Harrison, Ahn, & Adolphs, 2015; Marks & Nesse, 1994; Stein & Bouwer, 1997). Detecting a cue of social threat (i.e. to one's status), for example, entails a different set of processes than detecting a cue that a predator is lurking nearby (Sterelny, 2003). For instance, a social threat to status may uniquely require the visual decoding of signs of disapproval on another person's face and interpretation of their intentions. However, there are also shared aspects of threat-detection and response to seemingly disparate threats, such as a state of enhanced vigilance that is useful for many kind of dangers (Brilot, Bateson, Nettle, Whittingham, & Read, 2012; Eilam et al., 2011; Mobbs et al., 2015). Different anxiety responses may therefore represent partially segregated systems for the detection and subsequent management of different classes of threat encountered in past environments, particularly in cases where a generalized response would not sufficiently mitigate the risk (Brilot et al., 2012; Cosmides & Tooby, 1994; McNaughton, 1989; Nesse, 1990; Tooby & Cosmides, 1990).

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