



Review

Decision making under stress: A selective review

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ARTICLE INFO

Article history:

Received 6 July 2011

Received in revised form 30 January 2012

Accepted 2 February 2012

Keywords:

Stress

Decision making

Cognition

Emotion

Stress hormones

Neuroimaging

Neuropsychology

ABSTRACT

Many decisions must be made under stress, and many decision situations elicit stress responses themselves. Thus, stress and decision making are intricately connected, not only on the behavioral level, but also on the neural level, i.e., the brain regions that underlie intact decision making are regions that are sensitive to stress-induced changes. The purpose of this review is to summarize the findings from studies that investigated the impact of stress on decision making. The review includes those studies that examined decision making under stress in humans and were published between 1985 and October 2011. The reviewed studies were found using PubMed and PsycInfo searches. The review focuses on studies that have examined the influence of acutely induced laboratory stress on decision making and that measured both decision-making performance and stress responses. Additionally, some studies that investigated decision making under naturally occurring stress levels and decision-making abilities in patients who suffer from stress-related disorders are described. The results from the studies that were included in the review support the assumption that stress affects decision making. If stress confers an advantage or disadvantage in terms of outcome depends on the specific task or situation. The results also emphasize the role of mediating and moderating variables. The results are discussed with respect to underlying psychological and neural mechanisms, implications for everyday decision making and future research directions.

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1. Introduction

Many decisions must be made under stress. Examples of decisions that are made under stress include choosing the correct alternatives in an exam or making the best decision in an emergency. Additionally, many decision situations elicit stress responses themselves. The decision about whether to turn off life-saving machines for fatally ill patients or decisions that have extensive financial consequences are stress-eliciting in and of themselves. Thus, stress and decision making are intricately connected, and the influence that stress has on the quality of a decision is of special interest. The purpose of the present review is to summarize findings from studies that have investigated the impact of stress on decision making. The review indicates that stress alters decision making, suggesting that stress may affect how we make everyday decisions and life-altering choices. There is also a connection between stress and decisions on a neural level. The brain regions that are associated with intact decision making are sensitive to stress-induced changes. Nevertheless, studies that have investigated the effect of stress exposure and stress reactions on decision-making performance are rare compared to the wealth of studies that have investigated memory performance under stress (reviews in Lupien et al., 2007; Wolf, 2009). The present review aims to fill this research gap.

The effects of stress on decisions may be relevant to public health. The detrimental effects of stress on health are well documented. Stress is thought to increase the risk for cardiovascular, psychiatric and psychosomatic diseases, and it also encourages unhealthy lifestyle behaviors, such as smoking, drinking or unhealthy diet (Juster et al., 2010; McEwen, 2008; Schneiderman et al., 2005). Thus, stress may have indirect effects on health, and these effects may be mediated by the individual's suboptimal decisions, which offer immediate reward at the cost of long-term negative consequences.

2. Method of review

The present review has summarized studies of stress and decision making in healthy humans that were published between 1985 and October 2011. Due to the limited space of this article, the review omitted the effects of stress on the decision processes that underlie perception and attention, such as signal detection (review in Broadbent, 1971), memory (review in Wolf, 2009), executive functioning, such as set shifting and categorization (e.g., McCormick et al., 2007) or operant conditioning (e.g., Schwabe and Wolf, 2009). The review focused on decisions in a narrower sense including the choice among at least two alternatives that is generally made in complex situations. In daily life, most decisions have to be made among at least two options. Although in some situations, one option may be to act and the other not to act, in most cases, two or more options that provide different outcomes

are available (see examples in Brand et al., 2006). As stated by Balleine (2007), decision making refers to the 'ability of humans and other animals to choose between competing courses of action based on their relative value of consequences.' In accordance with this definition, the most popular tasks that assess decision making, for example in patients with neuropsychological impairments, comprise two or more options. Such tasks have also been applied to healthy participants to investigate personality and other individual factors that could potentially influence decision making. These decision-making tasks have also been used to experimentally investigate the effects of stress on decision making. In line with this research, the review focused on stress and decision making as measured by tasks that provide at least two choices, in contrast to more basic tasks in which subjects must simply react or fail to react to specific stimuli (such as Go/No-Go tasks or other, more basic, experimental paradigms that involve reaction times, and so on).

The present review begins with a short overview of decision-making research and stress research before their reciprocal relationship is elucidated. The review focuses on studies that have examined the influence of acutely induced laboratory stress on decision making. This section focuses on two databases that were searched for suitable articles. In PubMed, a search was conducted using the search terms 'decision making,' 'risk taking' and 'stress,' each of which was combined with each of the terms 'stress,' or 'social evaluation' using the conjunction 'AND.' Each term was required to be present in the 'Title/Abstract' of the paper. In PsycInfo, a search was conducted using the same search terms as in the PubMed search. Each term was required to be present in the 'Title.' Both searches were further limited by 'English' as the publication language and 'Publication Date from 1985 to October 2011.' The only studies that were selected for the review were original research papers that were published in peer-reviewed journals. All of the studies included healthy human participants and examined the acute induction of laboratory stress and its relationship with decision-making performance in a laboratory decision-making situation. Both variables, i.e., decision-making performance and stress responses, must have been quantified by the authors. The inclusion criteria were chosen to focus on neuroscientific studies about stress and decision making rather than on the wealth of existing studies and reviews concerning time pressure and decisions (e.g., Svenson and Maule, 1993). The following hits were retrieved from the search of PubMed: 'decision making' and 'stress' (884); 'risk taking' and 'stress' (132); 'selection' and 'stress' (3649); 'decision making' and 'social evaluation' (2); 'risk taking' and 'social evaluation' (1); 'selection' and 'social evaluation' (1). The following hits were retrieved from the search of PsycInfo: 'decision making' and 'stress' (362); 'risk taking' and 'stress' (156); 'selection' and 'stress' (26). A total of 17 studies fulfilled the above mentioned criteria and were included in this main section of the review.

After this main section, some studies that examined the relationship between naturally occurring stress levels and decision making

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