Physiology & Behavior 167 (2016) 274–281

Contents lists available at ScienceDirect

Physiology & Behavior

journal homepage: www.elsevier.com/locate/phb

The contribution of trait negative affect and stress to recall for bodily states

Christine Ma-Kellams [a,b,*], Lei Lai [c], Shelley E. Taylor [d], Jennifer S. Lerner [a]

[a] Harvard University, Kennedy School, 79 JFK St., Cambridge, MA 02138, United States
[b] Department of Psychology, University of La Verne, La Verne, CA 91750, United States
[c] Department of Management and Marketing, College of Business Administration and Public Policy, California State University, Dominguez Hills, United States
[d] University of California Los Angeles, Department of Psychology, 1285 Franz Hall, Los Angeles, CA 90095-1563, United States

HIGHLIGHTS

- Negative affect shaped recall of heart rate when controlling for actual heart rate.
- Individual differences in negative affect predicted visceral recollections.
- Those who experienced more negative affect were more inaccurate.
- Those high in trait negative affect remembered bodily states as worse than they were.

ARTICLE INFO

Article history:
Received 4 March 2016
Received in revised form 12 August 2016
Accepted 26 September 2016
Available online 28 September 2016

Keywords:
Stress
Performance
Retrospection
Psychophysiology

ABSTRACT

How does trait negative affect shape somatic memory of stressful events? We hypothesized that negative affect would impair accurate recall of one's own heart rate during stressful situations. Two bio-behavioral studies used a new paradigm to test retrospective visceral perception and assessed whether negative affective states experienced during aversive events (i.e., the Trier Stress Task—Time 1) would retrospectively shape recall of past heart rate (Time 2), even when accounting for actual heart rate at the time of each stressful event (Time 1). Results across both studies showed that individual differences in negative affect in response to a stressful task predicted visceral recollections, and those who experienced more negative affect were more inaccurate. Negative affect was associated with a tendency to remember visceral reactions as worse than they actually were.

1. Introduction

Much is known about how stress affects memory for the content of events, but little is known about how stress affects recall of the bodily states that accompanies such events. In relation to the former, legions of clinical evidence suggest that highly stressful events are remembered in vivid detail, so much so that they can lead to powerful and sometimes maladaptive memories that last a lifetime (for review, see [55]). At the same time, stress can also lead to loss of memory for details relevant to the event, and a substantive body of work has highlighted the ways in which stress can debilitate not only episodic memory (e.g., in the case of eyewitness memory—[11]), but also a host of related cognitive functions [23,31]. Over the past decade, a growing body of evidence has shown that the relationship between stress and episodic memory is highly nuanced—stress can facilitate, impair, or have no effect on memory as a function of a variety of factors [12,19,20,50,59].

To illustrate, stress can have very different effects on memory, and the nature of stress' effect depends not only on the kind of learning or memory process, but also on the time sequence of learning and the occurrence of stress. For instance, stress typically enhances memory when presented in the consolidation phase [33,44,51]. Previous studies have shown that stress hormones that are released during arousing experiences serve to facilitate memory consolidation via adrenergic and glucocorticoid activities in the amygdala (for review, see [34]). However, stress can also impair memory when presented during the encoding/acquisition [40] or the recall phase ([27,44,51]; for a review of these links between stress and memory, see also [49]). Moreover, given the importance of visceral-afferent signals regarding the body's physiological state in a host of brain and behavior processes (for review, see [9]) and the host of unconscious influence internal bodily changes can have on emotional and judgment processes (e.g., [60]), these suggest that visceral processes and emotional reactions to stress may mutually influence one another.

* Corresponding author at: Department of Psychology, University of La Verne, La Verne, CA 91750, United States.
E-mail address: cma-kellams@laverne.edu (C. Ma-Kellams).

http://dx.doi.org/10.1016/j.physbeh.2016.09.024
0031-9384/

Understanding this link is important because the impact of stress on memory for bodily states may represent an important mechanism for the generation of physical symptoms in some mental disorders, such as panic or somatoform disorders. For example, it can help explain the role of negative affect in a host of symptoms that involve heart rate, including histrionic, catastrophic thinking in response to stress and in clinical disorders marked by anxiety (e.g., panic attacks; [7]). Although no studies to our knowledge have directly looked at the role of negative affect in shaping memory for bodily states and its downward consequences for anxiety disorders, a number of existing studies have shown that interoceptive processes more generally are implicated in anxiety-related clinical symptoms. For example, those who are highly aware of their own bodily states tend to experience more depression symptoms, at least under conditions of high anxiety [39], and similar links have emerged between interoceptive awareness and anxiety symptoms [13]. However, clinical anecdotes have also suggested that bodily awareness and disorders do not always go hand in hand: patients with PTSD, for example, tend to report difficulty focusing on their bodily states [56]. Taken together, the existing literature suggests the need for a clearer understanding of the relationships between negative affect, bodily states, and perceptual outcomes. In doing so, these findings may assist practitioners who dismiss such presentation as histrionic or a product solely of an emotional disorder. They also add weight to recommendations to add screens for anxiety and depression in intake questionnaires (e.g., [38]). In this time of rising health care costs, emergency room visits, needless visits to physicians, the use of extensive resources for "heart attack" complaints that turn out to be phantom feelings could all potentially be reduced by a better understanding of these processes.

Thus far, the overwhelming majority of the aforementioned studies on stress and memory have focused on memories for the content of events. Scant research has examined the effects of stress on somatic memories, or memories of lived, bodily states. Nevertheless, previous research in the related field of state emotions has shown that *state* negative affect can be particularly useful for facilitating memory of focal, external details directly tied to the emotional features of the event (e.g., the gun in the context of a robbery) but may hamper the memory of peripheral details (e.g., of external details not directly tied to the emotional features of the event, like the context, or internal details—see [22,30]).

Moreover, the previous research has shown the beneficial effects of negative affect on details that are not only external and focal, but also relatively easy to encode—details about the physical features of objects and the presence or absence of specific events. Internal bodily states, in contrast, are far more difficult to encode. Although few studies have directly tested individual's capacities to remember past bodily states, a compelling body of empirical studies has provided indirect evidence that accurate encoding of past visceral experiences is difficult to do. For example, studies on colonoscopy patients found that their recollection of painful medical procedures were highly influenced by prototypical moments during the procedure (e.g., the peak and end) and did not take into account the entire duration of the procedure [24,25,43]. An additional illustration of this is the well-established hot-cold empathy gap in which individuals in "hot" (i.e., viscerally-salient) states fail to accurately predict their desires and behaviors in "cold" (i.e., non-bodily) states or vice versa (e.g., [29,36,37,41,42,45,54]). At the heart of hot-cold empathy gaps is the notion that individuals' memory for bodily states is highly constrained—that is, although they can remember the external circumstances that led to the visceral reaction, they have difficulty encoding and retrieving the actual sensory experience of the visceral reaction itself [29,36].

Despite the difficulty of accurately knowing one's own bodily states, individuals routinely are called to reflect on or recall their physiological arousal (e.g., in the context of medical reporting or diagnoses). Even if they are not highly aware of such arousal during the actual emotional episode, questions of what their bodies were doing may be an important cue in post-hoc constructions of the emotional episode.

We predict that individual differences in negative affect would impair memory of past bodily states. The more strongly people experience a stressful state, the more likely they are to rely on those affective cues when remembering their bodily response during that state, and such cues can bias memory. We contend that in the context of a stressful, negative event, internal bodily states—although crucial to the experience of the emotion itself—may be encoded as a peripheral detail in the perceiver's mind because it is not an external cue directly connected to the emotional cause of the event. In the context of a robbery, for example, a racing heart may be the least of one's worries, and far more attention (and encoding efforts) are afforded to the external causes of concern. Thus, in line with the aforementioned research, we hypothesize that individuals experiencing more negative affect in response to a stressful event will be likely to exhibit greater inaccuracy (i.e., increased extremity) in remembering the bodily states experienced during such circumstances, even when actual bodily states are controlled for. Given that a) related studies show that negative affect in general tends to enhance memory for central cues, like details relating to the emotion-inducing event, but impair memory for peripheral details, such as all cues not directly tied to the event and b) bodily states stand as a peripheral cue that is highly difficult to encode, we predict that individual variation in negative affect in response to an aversive external event will hurt recall of the bodily state experienced during the event. Across two studies, we investigated the hypothesis that negative affect experienced during a stress task would predict more extreme retrospective reports of bodily states, such that individuals who experienced more negative affective states would retrospectively report greater visceral changes than what they actually experienced. In both studies, we induced stress through external circumstances—in this case, stimulation via an engaging, difficult task.

Across both studies, we specifically used retrospective measures so that we could assess judgment and recall rather than online interoception. We focused on recall judgments because of its real-world application—namely, no one reports to their doctor in the moment they feel stress. Rather, they report the retrospective judgment of their responses to their doctor. Thus, we developed a new experimental paradigm that assessed retrospective visceral perception and its link to negative affect.

2. Study 1

2.1. Method

2.1.1. Participants

Members of a university community responded to an ad offering $60 in return for participation; all consent procedures, methods and recruitment were approved by the IRB committee prior to the start of the study. Fifty-one participants (28 males and 23 females), screened for mental and physical health (i.e., no reported physical or mental health problems, use of medications affecting cardiovascular or endocrine functions, current treatment from a mental health professional, current use of mental-health related medication, current pregnancy or lactation), comprised the final sample. Ages ranged from 18 to 27 (M = 19.80, SD = 2.16), and the racial/ethnic composition of participants was 2% African-American, 41% Euro-American, 39% Asian-American, 6% Hispanic American, and 12% mixed or other race/ethnicity.

2.1.2. Setting and apparatus

Participants completed informed-consent forms and psychosocial self-report scales (see below). Approximately one week later, participants reported to a psychophysiology laboratory and were seated adjacent to cardiovascular equipment and directly in front of a video camera. They were fitted with blood pressure monitors; a Critikon Dinamap Vital Signs Monitor Model 1946XC (Critikon, Inc. Tampa, FL) automatically and continuously recorded heart rate and blood pressure