Learning and Instruction 54 (2018) 1–10

Contents lists available at ScienceDirect

Learning and Instruction

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

Dynamic psychophysiological correlates of a learning from text episode in relation to reading goals

Sara Scrimin[a,*], Elisabetta Patron[b], Erlis Ruli[c], Clovis Euloge Kenne Pagui[c], Gianmarco Altoè[a], Lucia Mason[a]

[a] Department of Developmental Psychology and Socialization, University of Padova, Italy
[b] Department of General Psychology, University of Padova, Italy
[c] Department of Statistical Sciences, University of Padova, Italy

ARTICLE INFO

Keywords:
Physiological measures
Reading goals
Text comprehension
Learning

ABSTRACT

This study aimed to investigate undergraduates' cardiac activity during an episode of complex learning from text. Specifically, we examined (a) heart rate (HR) and (b) heart rate variability (HRV) as psychophysiological measures while students read a science text and were tested on it. Reading goals were also taken into account: Students were asked to read for themselves to know more on a topic, or to read to perform well to gain course credit. Undergraduates (N = 50) were randomly assigned to one of the two reading goal conditions. Their HR and HRV were registered at baseline, while reading the text, during the testing phase, and while recovering from the task. Findings confirmed that in the condition with the reading goal focused on good performance, the students comprehended the text better than the students who read for themselves. Two mixed-effects models examined HR and HRV trends during the four phases of the learning episode. Findings showed a general trend in which students' HRV was greater in the reading phase compared to baseline. HR decreased during reading and increased during the testing phase. This pattern indicates a deep cognitive effort of students while reading that gave way to higher psychophysiological arousal in the testing phase. Moreover, a series of linear regression models revealed that being under aroused and in a state of receptive calm during the reading phase allowed greater performance. Educational implications are drawn.

1. Introduction

Cognitive processes underlying learning, as well as emotional experiences involved in learning activities, are strictly linked to the physiological state of the body. A long tradition of studies exists on the physiology of the heart and its connections with the brain. Two interconnected pathways have been documented through which the prefrontal cortex can control cardiac functions. Given the significant role of the prefrontal cortex in attention, executive functions, memory, language, and visual search processes, the cardiac activity associated to this brain region can be an important physiological marker of academic learning processes (e.g., Thayer, Hansen, Saus-Rose, & Johnsen, 2009).

Within the field of psychophysiology, several studies have described heart rate activity while performing specific cognitive tasks, yet very few studies have investigated cardiac responses to real-life assignments typically encountered by students in educational settings. In this regard, reading comprehension is essential to learning in most educational contexts as well as in everyday life. In academic settings, the ability to comprehend and learn from text is periodically tested placing students in the position to deal with frequent challenges. Both research and educational practice have indicated that text processing and comprehension are influenced by readers' expectations and goals (McCrudden, Magliano, & Schraw, 2011), which contribute to various dimensions of their engagement during reading.

To extent current research, the aim of the present study was to examine undergraduates' cardiac activity while they read a science informational text and answer questions on it. Specifically, students' heart rate (HR) and heart rate variability (HRV) were registered. Different reading goals, such as to read for themselves to know more on a topic, or to read to answer to at least 50% of the post-reading questions to gain course credit, were included in the study to investigate different degrees of challenge for the student, thus different levels of elicited arousal. Specifically, the latter reading goal is supposed to be more arousing than the former, that is, reading to perform at a certain level is more challenging than the former reading goal. By registering students' psychophysiological responses while reading in a less and

* Corresponding author. Department of Developmental Psychology and Socialization, University of Padova, via Venezia 8, 35131 Padova, Italy.
E-mail address: sara.scrimin@unipd.it (S. Scrimin).

https://doi.org/10.1016/j.learninstruc.2018.01.007
Received 14 February 2017; Received in revised form 21 December 2017; Accepted 28 January 2018
Available online 16 February 2018
0959-4752/ © 2018 Elsevier Ltd. All rights reserved.

more arousing reading condition, we can gain new insights on person-related micro-level engagement processes during a fundamental learning task, such as comprehending an informational text (Fulmer & Tulis, 2013). Understanding the psychophysiological processes that may enhance or hamper the various phases of an entire learning from text episode (baseline, reading, testing, and recovery) has important implications for academic achievement.

1.1. Cardiac activity: heart rate and heart rate variability

Communication from the brain to the heart is continuous and pervasive. Cardiac activity is not only linked to a set of neural structures that are implicated in cognitive functions, but is also essential when responding to challenging situations and self-regulating in responding to environmental demands.

The two branches (sympathetic and parasympathetic) of the autonomic nervous system (ANS) strictly regulate cardiac activity (Kreibig & Gendolla, 2014). When active, the sympathetic system determines increase in heart rate (HR) and stroke volume, regulating the response to threat or stressful situations. An increase in sympathetic activity correlates with an acceleration in heart rate, which reflects a higher level of arousal (Appelhans & Luecken, 2006). The parasympathetic system reduces heart rate, allowing energy regain and storage. Specifically, the vagal nerve acts as a "brake" (Porges, 2007a,b): When it is activated, the cardiac system is slowed down and prevented from becoming overexcited; when this "brake" is removed, the cardiac system is activated and ready to respond. In other words, the more the vagal brake is activated and the learner is in a balanced state of concentration and calm, the more she can physiologically self-regulate and adapt to task requirements.

This phychophysiological concept is closely intertwined with the crucial concept of self-regulated learning in educational research. Self-regulated learning refers to the "processes whereby learners personally activate an sustain cognitions, affects, and behaviors that are systematically oriented toward the attainment of personal goals" (Zimmermann & Schunk, 2011, p. 1). It means that self-regulated students are internally driven and supported by motivation in setting their learning goals, implementing effective learning strategies, monitoring their progress, establishing environmental conditions conducive to learning, and keeping a sense of self-efficacy for learning (Winne, 2001; Zimmermann & Schunk, 2011). However, in the present work we do not consider self-regulated learning in its multi-component educational perspective, but rather we focus on the physiological and "basic" capacity to change or inhibit thoughts, emotions, impulses, or overt behaviors (Baumeister & Newman, 1994).

Based on a functional framework that integrates affective regulation, attentional regulation, and heart rate variability (Thayer & Lane, 2000), we link variations in cardiac activity not only with stress or emotional response and regulation, but also with cognitive processes (Porges, 2007a,b). Several studies have reported that increases in arousal levels during high demanding cognitive tasks, which place the individual in a challenging condition, are reflected in HR increases (Critchley, Corfield, Chandler, Mathias, & Dolan, 2000; Mathewson et al., 2010). For example, an effortful mental arithmetic task, such as covertly performing serial subtractions of numbers as rapidly as possible, evokes significant greater increases in HR compared to an effortless arithmetic task, such as counting in ones at a steady rate (Critchley et al., 2000). Moreover, higher physiological arousal during a word discrimination task of greater difficulty was related to better performances compared to easier and less arousing tasks (Gellatly & Meyer, 1992). Hence, the association between arousal and performance is well-established, however little is known on the role of arousal, as directly measured in terms of HR, in learning from text.

Research has also consistently reported that parasympathetic activity on the heart is related to attention, working memory (Porges & Raskin, 1969; Thayer et al., 2009), and executive functioning (Hansen, Johnsen, & Thayer, 2003). For example, on a continuous performance test, which assesses sustained attention and working memory, participants with high heart rate variability (HRV) performed better compared to those with low HRV (Backs & Seljos, 1994; Thayer et al., 2009). Similarly, Hansen et al. (2003) found that high parasympathetic activity was associated with better performance in a task involving executive functioning. Modifications of HRV when preparing to meet the demands of a cognitive task have been proposed to reflect self-regulation (Segerstrom & Solberg Nes, 2007) and engagement in the task (Beauchaine, 2001). HRV is thought to reflect the integrity of integrative functioning across the central and autonomic nervous systems in the service of goal-directed behavior. Hence, an increase in HRV indicates an active self-regulatory process that is linked to an increased effort actively placed on the task at hand. When students concentrate on the task, for example paying attention and inhibiting the responses to other requests that might come from the environment, their HRV increases. Previous studies have shown that individuals who report good control over impulses and focus on the task, show an increase in HRV, whereas those with poor control do not (Ingjaldsson, Laberg, & Thayer, 2003; Smith et al., 2011). Thus, HRV can be viewed as a sensitive measure of cognitive effort, yet data are needed on how it changes during a learning episode.

Based on the above-mentioned literature it is clear that both sympathetic and parasympathetic activities of the autonomic nervous system are involved in students' academic tasks. On the one hand, performance in academic settings is linked to different degrees of arousal (Chauncey Strain, Azevedo, & D'Mello, 2013; Linnenbrink-Garcia & Pekrun, 2011; Mills, D'Mello, & Kopp, 2005; Pekrun, 2005). For example, students often face challenges due to testing and the related goal to perform at their best. The adaptive response to such environmental demands is the activation of the sympathetic branch of the autonomic nervous system, which can be indexed as an increase in heart rate. On the other hand, higher parasympathetic activity indexed by greater heart rate variability implies a good self-regulation and calm state that can favor a better cognitive performance.

Cardiac activity of the autonomic nervous system registered during an entire learning from text episode can usefully indicate students' arousal (HR) and cognitive effort (HRV), and hence be used to examine its underlying person-related micro-level dynamics.

To the best of our knowledge there are only two published studies addressing the relation between cardiac activity and reading. Becker et al. (2012) examined cardiac vagal tone (HRV) both at rest and during challenge to assess if variations in cardiovascular activity would predict reading achievement in typically developing children. Results showed that greater cardiac vagal tone suppression during the challenging tasks was associated with better reading achievement, yet higher basal levels of cardiac vagal tone did not predict better reading scores. These results offer new insight into the association between students' response to an arousing task, reading, and autonomic regulation of the heart. However, the study did not directly investigate reading performance by measuring cardiac reactivity as the student is engaged in reading a text and later answering questions on it.

Autonomic activity during a reading task was also assessed by Daley, Willett, and Fischer (2014). They investigated cardiac vagal tone in middle school students during a reading task in which they were asked to read two passages and recall them orally. Results revealed that the reading physiological response predicted reading comprehension as revealed by the verbal retelling performance. Students who showed greater comprehension were those who had an initial brief orientation response after hearing the instructions (reduction in vagal tone) and then an increase in vagal tone, reflected by a state of calm as a function of the appraisal and engagement process (Daley et al., 2014).

Hence, an increase in vagal tone while reading has been proven to be associated with better online reading comprehension (Daley et al., 2014), and cardiac vagal suppression during a challenging task was associated with better reading achievement (Becker et al., 2012).

Download English Version:

https://daneshyari.com/en/article/6845624

Download Persian Version:

https://daneshyari.com/article/6845624

Daneshyari.com