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Maintenance of parasympathetic inhibition following emotional induction in patients with restrictive type anorexia nervosa

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ABSTRACT

This study aimed to explore changes in heart rate variability (HRV), a proxy for parasympathetic activity characterizing emotion regulation processes before, during and after negative emotional induction in patients suffering from restrictive type anorexia nervosa (AN-RT). We compared two methods of HRV analysis, the Fast Fourier Transform high frequency (FFT-HF) and a specific HRV high frequency analysis technique, namely, the wavelet transform HRV (WT-HRV). A sample of 16 inpatients with AN-RT was compared to 24 control participants. Heart rate (HR) was continuously recorded for 5 min before the beginning of the video until 5 min after the video. The participants answered questionnaires concerning their eating behaviors, mood disorders and difficulties in emotion regulation. During the entire procedure, the FFT-HF in patients was lower than that in controls. Using the WT-HRV, the patients did not differ from the controls at baseline, and only the controls showed a decrease during emotional induction. After the video, the WT-HRV in patients began to decrease during the first 2 min of emotional recovery although the WT-HRV in controls was already increased. These results highlighted the disturbances in the physiological dynamics of emotion regulation processes in patients with AN-RT.

1. Introduction

A chronic lack of emotion regulation is involved in the development and maintenance of a large number of psychopathologies (Kring and Bachorowski, 1999; Bradley, 2000; Greenberg, 2002; Berenbaum et al., 2003; Kring and Werner, 2004; Mennin and Farach, 2007; Berking and Wupperman, 2012), particularly eating disorders (ED) (Connan et al., 2003; Oldershaw et al., 2011).

The majority of studies that have examined emotion regulation processing in patients suffering from anorexia nervosa (AN) have been conducted using self-report questionnaires. Thus, the patients suffering from AN reported more difficulties in accessing emotional regulation strategies (Whiteside et al., 2007; Harrison et al., 2009, 2010a, 2010b; Svaldi et al., 2012), an inefficiency of the strategies that they used (Gilboa-Schechtman et al., 2006; Harrison et al., 2009, 2010a, 2010b; Svaldi et al., 2012) and a predominant use of inappropriate strategies to the detriment of more efficient emotion regulation strategies (Gilboa-Schechtman et al., 2006; Harrison et al., 2009, 2010a, 2010b; Svaldi et al., 2012). Using a meta-analysis, Aldao et al. (2010) found a positive correlation between ED and avoidance strategies, rumination and suppression, an absence of link between ED and cognitive reappraisal and a negative correlation between ED and problem solving.

However, few experimental studies (Cooper, 1997; Cavedini et al., 2004, 2006; Tchanturia et al., 2007) have reported deficits in emotion regulation among patients suffering from AN that appear to resolve after clinical and weight improvements (Tchanturia et al., 2007). Yet, the majority of studies that have examined emotion regulation processing in patients with AN have been conducted using self-report questionnaires (Peñas-Lledó et al., 2002; Corstorphine et al., 2007; Harrison et al., 2009, 2010a, 2010b; Aldao et al., 2010; Svaldi et al., 2012). Because these previous studies have been conducted with self-report evaluations that are biased by self-esteem and awareness of one's skills (Aldao et al., 2010), the use of experimental emotional induction combined with assessment of physiological measures represents an additional means for assessing emotion regulation in this population (Koole, 2009).

Several cardiovascular measurements have been used to characterize emotion regulation processes. Heart rate (HR) was the most

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commonly used in the emotion literature (Kreibig, 2010); however, HR is considered to be an approximate index that cannot describe the complexity of heart regulatory processes (Allen et al., 2007) because of the combined influence of both the sympathetic and parasympathetic activities on this measure. In fact, fluctuations in the length of the interbeat interval (heart rate variability [HRV]) and more precisely, a higher tonic (resting) level and a greater magnitude of change from rest to task are a good index of cardiac vagal control, which is perceived to underlie the ability to regulate emotions and respond appropriately (Beauchaine, 2001; Butler et al., 2006).

Results have generally supported this assumption that a higher tonic HRV reflects a greater capacity for regulated emotional responses and self-regulation (Thayer et al., 2009; Park et al., 2014) and that conversely, a lower tonic HRV is a signature of emotion dysregulation (for a review, see Appelhans and Luecken (2006)) and a poorer self-regulatory capacity (Thayer and Lane, 2000). Moreover, according to Porges (1995, 1997, 2001), the decrease in parasympathetic activity in response to stimulation (phasic cardiac activity) may represent stress experienced by the individual, whereas the level of parasympathetic activity observed before stimulation represents vulnerability to stress.

Nevertheless, as underlined by Park et al. (2014), compared to tonic (resting) cardiac activity, relatively little is known regarding the role of phasic cardiac activity in the context of self-regulation (Thayer and Lane, 2000; Segerstrom and Nes, 2007). When people are exposed to a stressful situation, with emotion elicitation paradigms using video clips (Berna et al., 2014), or when people are engaged in aversive or worrisome mental imagery (El-Sheikh et al., 2011), phasic HRV suppression occurs. This decrease in HRV has been considered to be an autonomic response to stress, which represents the withdrawal of cardiac vagal control and the activation of the defensive system (Thayer et al., 1996).

In the field of ED, various experimental procedures and measures of parasympathetic activity have been conducted to reflect the parasympathetic functioning of these patients. A literature review (Mazurak et al., 2011) reported a parasympathetic hyperactivity generally observed in patients suffering from AN at rest or during a 24-h recording. Specifically, despite methodological differences, research generally supports the notion of tonic (at rest) parasympathetic hyperactivity in patients suffering from ED and starvation (Petretta et al., 1997; Galetta et al., 2003; Green et al., 2009; Vögele et al., 2009; Jacoangeli et al., 2013; Bomba et al., 2014). The parasympathetic hyperactivity reported in these patients does not support the observations of Thayer et al., whereby a tonic parasympathetic activity reported best abilities in emotion regulation. However, according to the authors (Casper, 1986), the tonic parasympathetic hyperactivity in patients suffering from anorexia nervosa restrictive type (AN-RT) is the body's adaptation to starvation. Several studies did not find this hyperactivity (Melanson et al., 2004; Murialdo et al., 2007), and the authors reported hypoactivity in patients suffering from AN-RT (Rechlin et al., 1998; Lachish et al., 2009). Additionally, Yoshida et al. (2006) reported a decrease in parasympathetic hyperactivity after a period of refeeding in young patients suffering from AN-RT.

Following the proposals by Thayer et al. and because phasic parasympathetic activity of patients with AN-RT has not been studied after the induction of an emotional state, the primary objective of this study was to assess parasympathetic activity before, during and after the induction of negative emotion in patients suffering from AN-RT to characterize the physiological dynamics of emotion regulation over time.

To assess parasympathetic activity, we decided to test two HRV-based solutions, namely, the Fast Fourier Transform (FFT) and a specific innovative HRV high frequency analysis technique, the wavelet transform HRV (WT-HRV). This technology, initially developed to evaluate pain during surgical procedures (Logier et al., 2010; Jeanne et al., 2012), is based on the ventilatory influence on heart rate and can be considered to be a measure of parasympathetic activity. Recently, De Jonckheere et al. (2012) showed that this index allowed researchers to observe the dynamics of parasympathetic activity during emotional induction in a non-clinical sample and the time required to regulate one's emotional state and to return to their baseline parasympathetic activity.

We assume that patients with AN-RT will require more time to recover their baseline parasympathetic activity after emotional induction, suggesting greater difficulties in regulating emotion. Furthermore, we assume that there will be a tonic parasympathetic hyperactivity in patients suffering from AN-RT.

In addition to the primary objective, we will assess the effects of clinical variables, such as depression and anxiety levels, reported difficulties in emotion regulation and interoceptive awareness on tonic and phasic parasympathetic activity.

2. Methods

2.1. Participants

The sample consisted of inpatients suffering from AN-RT from the psychiatric unit of a general hospital in the north of France (Hospital Saint-Vincent at Lille). Because self-starvation influenced the parasympathetic activity (Petretta et al., 1997; Galetta et al., 2003; Green et al., 2009; Vögele et al., 2009), only patients with AN-RT and an average body mass index (BMI) of 15 were included in this study. The subtypes of eating disorders are important inclusion criteria that should be considered. Danner et al. (2014) found differences across ED subtypes concerning the types of emotion regulation difficulties underlining the importance of considering ED subtypes in emotion regulation research.

Of 31 patients included in the experiment by the psychologist in charge of the study, 12 patients were excluded from the research study due to missing data. Additionally, three patients were excluded from the study because they were highly anxious before the emotional induction. We excluded participants with an HRV index less than 71 at baseline, which is indicative of the presence of anxiety prior to the emotional induction (De Jonckheere et al., 2012). A total of 16 patients were included in the final sample. At the beginning of the hospitalization, the patients were interviewed by a psychiatrist and a psychologist and were diagnosed using the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition criteria (APA, 1994) for a current diagnosis of AN-RT. All of the patients were currently being hospitalized at the time of the study (from one to five hospitalizations) and were treated with individual or group psychotherapy and family psychotherapy. The average BMI was 15, and the average illness duration was 3 years (between 6 months and 8 years of illness). Group characteristics are shown in Table 1.

Initially, 25 healthy young women consented to participate in the experiment as a control group; one participant was excluded because of high anxiety levels before the experiment. The 24 remaining control participants were healthy students who were recruited at a university or college and were of the same age and educational level as the patients and were assessed by the psychologist who was in charge of the clinical evaluation in the study.

The patients with AN-RT and the control participants who suffered from neurological disorders, co-morbid post-traumatic stress disorder, intellectual deficits and a recent history of drug or alcohol abuse were excluded from the study. After they had been informed regarding the procedure and objectives of the study, all of the subjects signed a consent form and agreed to participate in the experiment. The local medical committee approved the protocol. The patients were informed that refusing to participate would have no effect on the quality of their medical care.

2.2. Measures

2.2.1. Experimental procedure

All of the participants were assessed between 1 p.m. and 3 p.m. in a quiet room with soft lighting to avoid any influences on parasympathetic measures.

Three electrodes for live ECG recording were placed on the wrists of the participants at the beginning of the procedure. After the participants rested for 5 min, the experimental procedure and the ECG recording were begun (Fig. 1). The experimental procedure consisted of the following three steps:

- "Baseline": Before presenting a short film that was intended to induce negative emotions, an ECG recording was obtained for 5 min.
- "Emotional induction": Westermann et al. (1996) showed that among several other techniques, film clips were the most potent inducers of negative mood states; hence, a negative emotional state was induced by the projection of an 80-s video. The clip was a sample of the film, "American History X",