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# Heart rate variability changes and emotion regulation abilities in short- and long-term abstinent alcoholic individuals

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ABSTRACT

*Introduction:* Difficulties in identifying and regulating emotion are recognized as major factors of relapse in alcohol use disorders (AUD). This study aimed to evaluate the differences of emotion regulation processes in AUD patients with short-term (STA, less than one month) and long-term abstinence (LTA, at least six months) by recording the high frequency of Heart Rate Variability (HF-HRV) in response to emotional and neutral stimuli.
*Method:* Emotional induction constituted the presentation of highly emotional and neutral pictures (IAPS data base) presenting human interactions. HF-HRV was recorded before (at rest), during (pictures) and after emotional induction (recovery).
*Results:* The results showed higher phasic HF-HRV in the STA group in comparison to the LTA and C groups for negative, positive and neutral stimuli. In the LTA group, we observed a normalization of HRV, in response to emotional stimuli. However, for negative valence stimuli in the recovery period, LTA participants are no more different from STA group. A main positive correlation was observed for both patient groups between craving scores and increased HF-HRV during and after the emotion induction.
*Conclusion:* The data support the hypothesis of emotion regulation impairment after STA but also show a partial improvement with prolonged abstinence. This impairment in patients may correspond to the maintenance of negative feedback that accentuates the difficulties in the emotional physiological process and limits the ability to engage in or maintain other processes. HF-HRV is a good indicator of emotion regulation processes related to the intensity of the craving even after long-term abstinence.

## 1. Introduction

Difficulties in the regulation of negative affect have been described as a major factor involved in the development and maintenance of substance use disorders (Berking et al., 2011; Baker et al., 2004). Emotion regulation abilities refer to skills by which individuals evaluate and modify emotional reactions to accomplish their goals (Thompson, 1994). Individuals with poor emotion regulation abilities may use substances to escape the down-regulation of their emotions (Koob and Le Moal, 1997) and/or stressful situations (Sinha, 2012). In addition, difficulties in emotion regulation are observed in the increased urge to drink (Sinha et al., 2009) and can predict cravings (Willinger et al., 2002).

### 1.1. Evolution of emotion regulation mechanisms with abstinence

With short-term abstinence, AUD patients present recoveries including decreased craving and negative affect (from 14 to 18 days of abstinence; Cordovil de Sousa Uva et al., 2010) and decreased depression, anxiety and alexithymia (from 2 days to 2 weeks of abstinence; de Timary et al., 2008). Differences in the degree of improvement are observed according to the duration of abstinence. Using the DERS (Difficulties in Emotion Regulation Scale), Fox et al. (2008) showed evidence of the recovery of emotional deficits in patients after short-term abstinence (from 5 to 6 weeks) and especially emotional awareness and clarity of emotional experiences. Using different scales (the Level of Awareness Scale (LEAS) and the Toronto Alexithymia Scale (TAS)), Bochand and Nandrino (2010) observed an improvement in emotional awareness following long-term abstinence (from 6 months to

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4 years) but the maintenance of emotion expression difficulties. Moreover, even after longer periods of abstinence, emotional and cognitive difficulties are still present in decision making (6 months to 6 years) (Fein et al., 2004), visual-spatial abilities, perceptual motor integration, abstract reasoning and new learning (2 months to 5 years) (Fein et al., 1990). The persistence of such deficits is believed to be a major factor in relapse and the difficulty experienced in maintaining abstinence. These deficits can also be examined as vulnerability factors in environmental and physiological demands.

Nevertheless, most of these emotion regulation disturbances have been observed from self-reported measurements through questionnaires. We argue that the characterization of self-regulation abilities implies the combination of a subjective assessment of emotional processes with physiological measures.

### 1.2. Physiological measures of ER: tonic and phasic heart rate variability (HRV)

Among the several cardiovascular measurements that have classically been used to characterize emotion regulation processes, fluctuations in the length of interbeat intervals (heart rate variability or HRV) is a precise measurement of the continuous interplay between sympathetic and parasympathetic influences on the heart rate, which yields information about autonomic flexibility (Appelhans and Luecken, 2006). The analysis of the spectral density of HRV constitutes a robust method to characterize both sympathetic and parasympathetic activities (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). Generally, researchers distinguish very low frequencies (< 0.04 Hz), low frequencies (0.04–0.15 Hz) and high frequencies (0.1–0.4 Hz) (Berntson et al., 1997). High frequencies (HF-HRV) are especially linked to the activation of the vagus nerve and are recognized as a valid and reliable indicator of parasympathetic activity (Pagani et al., 1986; Akselrod, 1988). The neurovisceral integration model (Thayer and Lane, 2000) and the polyvagal theory (Porges, 1995) suggest that HF-HRV is a marker of the level of cognitive, behavioral and emotional regulatory abilities. Efficient cardiac control facilitates a more flexible engagement with the environment and more efficient emotion regulation (Thayer et al., 2009; Hastings et al., 2008).

Resting or “tonic” cardiac vagal activity is recognized as an indicator of self-regulatory functioning (Park et al., 2014). Individuals with high tonic HRV respond better to stress (Brosschot et al., 2007) and express more positive emotions (Oveis et al., 2009) with better cognitive, emotional and autonomic self-regulatory capacities (Thayer et al., 2009; 2000). A decrease in HRV corresponds to low efficiency levels of autonomic control (Porges, 2007) and is associated with poorer self-regulatory (Thayer and Lane, 2000) and adaptation (Appelhans and Luecken, 2006; Thayer and Brosschot, 2005) capacities. In this line, low resting HRV is observed in several mental disorders and can be considered a transdiagnostic biomarker of psychopathology (Beauchaine and Thayer, 2015).

To date, while empirical evidence related to tonic HRV has grown, relatively little is known about the role of phasic cardiac activity in the context of self-regulation (Berna et al., 2014; Butler et al., 2006; Park et al., 2014). It is necessary to distinguish these two measurements (obtained at rest or during an emotion induction and a cognitive task) to investigate the ability to regulate environmental changes (Thayer and Lane, 2000; 2009). Indeed, when people are exposed to a stressful situation or negative videos (Beauchaine et al., 2007) or produce aversive or worrisome mental imagery (Lyonfields et al., 1995; Thayer et al., 1996), phasic HRV suppression occurs. This decrease in HRV has been considered an autonomic response to stress, which represents the withdrawal of cardiac vagal control and the activation of the defensive system (Thayer and Brosschot, 2005).

### 1.3. Heart rate variability and AUD

HRV has been studied to assess the alcohol-cue reactivity in AUD patients as an indicator that correctly reflects stress-precipitated appetitive responses (Garland et al., 2012) and homeostatic regulation of this stress context (Appel et al., 1989). A study by Rajan et al. (1998) showed that AUD patients (abstinent for 14 days) presented higher HRV than social drinkers in the alcohol-cue condition as well as a tendency toward neutral cues. Similar results were obtained with an imaginary alcohol script paradigm, in which AUD patients showed lower tonic HRV and increased HRV during the imaginary alcohol exposure compared to the controls (Ingjaldsson et al., 2003). Moreover, individuals who were severely dependent on alcohol presented a sustained phasic HRV acceleration when processing alcohol information, indicating a defective vagal modulation of cardiac function (Stormark et al., 1995).

This ability to control impulses and adjust to the environment has also been studied in terms of craving (defined as an intense desire for alcohol; Skinner and Aubin, 2010), which is especially involved in the maintenance of dependence. It has been shown that HRV predicts overall alcohol craving in AUD patients in relaxation states (Quintana et al., 2013a). Patients with low self-efficacy present more difficulties in adapting to the environment and controlling alcohol cues (Garland et al., 2012) and are less able to resist craving (Loeber et al., 2006). In addition, Ingjaldsson et al. (2003) showed that compulsive behavior was inversely related to tonic HRV during imaginary alcohol exposure but not for the obsessive or total scale.

### 1.4. Aims of the study

Although a set of studies has reported deficits in emotion regulation and a decrease in tonic HRV, less is known about phasic cardiac activity in AUD patients, especially in relation to the length of their abstinence. Using the changes in the High Frequency band of the HRV (HF-HRV), the aim of this study was to compare HF-HRV in response to emotional and neutral stimuli in two groups of AUD abstinent patients, according to their length of abstinence. We studied one group of patients with a short-term abstinence period (STA, less than one month after withdrawal) and another group with a long-term abstinence period (LTA, abstinence longer than six months) compared to healthy control participants (C). We hypothesized that HF-HRV would be lower in the STA group than in the LTA and C groups during the rest period. In contrast, we expected higher HF-HRV in the STA group compared to the LTA and C groups in emotional induction and for both negative and positive emotional stimuli. We also explored the possible relationships between HF-HRV and drinking history variables.

## 2. Method

### 2.1. Participants

The protocol was approved by a French ethics committee (CPP N° 2014-A0010542). Three groups of 35 participants, aged between 18 and 60 years, were studied: AUD patients with short-term abstinence (STA) (less than one month after withdrawal at the end of their hospitalization or after their outpatient withdrawal) and long-term alcohol abstinence (LTA) individuals (6 months to 15 years of abstinence) compared to healthy control participants (C). All participants gave their informed consent to participate after a thorough explanation of the study procedures. They were assessed for inclusion by a psychologist and an addictologist, and submitted to a breathalyzer test before the experiment (Alcosensor IV Set Accuracy check procedure, with the threshold for inclusion at 0).

Short- and long-term abstinent participants were recruited in the Addictology Department of the University Hospital in Lille (France) or were members of Alcoholics Anonymous in France (AA). The inclusion