



Heart rate correlates of utilitarian moral decision-making in alcoholism



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ABSTRACT

Background: Recent studies of moral reasoning in patients with alcohol use disorders have indicated a 'utilitarian' bias, whereby patients are more likely to endorse emotionally aversive actions in favor of aggregate welfare (e.g., to kill a person in order to save a group of people). The aim of the present study was to examine psychophysiological correlates of this tendency indexed by heart rate.

Methods: The sample was composed by 31 alcohol-dependent individuals and 34 healthy controls without alcohol use disorders. Electrocardiogram was recorded at rest and during execution of a validated moral judgment task, including non-moral scenarios, and moral dilemmas that were either high in emotional salience ("personal scenarios") or low in emotional salience ("impersonal scenarios").

Results: Alcohol-dependent individuals showed a blunted response to moral dilemmas. Furthermore, healthy controls displayed decreased heart rate to the personal vs. impersonal or non-moral scenarios, while alcohol-dependent individuals failed to differentiate dilemmas in terms of heart rate both prior decision-making and its post appraisal. These deficits were not related to baseline differences in Heart Rate.

Conclusion: Our findings indicate that alcohol-dependent individuals failed to engage emotional aversive reactions to personal moral violations in terms of heart rate response.

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1. Introduction

The somatic-marker model of addiction posits that addicted individuals exhibit problems to raise and process the emotional signals that normally guide adaptive decision-making (Verdejo-García and Bechara, 2009). When decision-making is framed in the context of moral judgment this notion is reminiscent of the dual-process model (Greene, 2007; Greene et al., 2008). This model posits that the surge of negative emotional states during consideration of personal moral dilemmas tend to foster deontological choices (i.e., refuse to harm someone regardless of its beneficial implications for societal well-being). However, in absence of these emotional signals moral decision-making is more likely to be approached from a cost–benefit analysis

which favors utilitarian choices (i.e., smothering a baby to save a group of people during wartime). Recent studies demonstrate that alcohol-dependent individuals compared to non-alcohol using controls tend to endorse more utilitarian choices when faced with personal moral dilemmas (Carmona-Perera et al., in press; Khemiri et al., 2012). In addition, they rate these utilitarian choices as less difficult to make (Carmona-Perera et al., in press). Because the utilitarian choice patterns specifically emerge in response to personal emotionally salient dilemmas, and because difficulty ratings can be viewed as a proxy of the degree of emotional burden involved, we have proposed that the utilitarian choice patterns of alcohol-dependent subjects are associated with deficits to raise negative emotions during consideration of moral dilemmas. However, this notion has not been yet been tested using physiological recordings during moral judgment. Since choice-related negative emotions normally increase awareness about decisions' consequences and make judgment more conservative (Clare and Huntsinger, 2007), we reason that this deficit

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may have important clinical implications (i.e., alcohol patients being more prone to make decisions without full consideration of consequences).

In order to evaluate the physiological concomitants of emotional responses, we assessed the heart rate (HR) response evoked by moral dilemmas. HR changes are considered to be an indicator of the valence dimension of emotion, since HR tend to decrease under the experience of negative emotions and to increase when we experience positive ones (Greenwald et al., 1989; Lang et al., 1993). Accordingly, evidence shows significant HR decreases in response to a plethora of unpleasant stimulus, including the reading of emotional drama texts (Danko et al., 2011; Lacey and Lacey, 1970) or the passive viewing of unpleasant pictures and films (Lang et al., 1993; Palomba et al., 2000). Blunted HR reactivity to emotional stimuli has been demonstrated in alcohol dependent individuals compared to healthy participants (Kornreich et al., 1998; Ryan and Howes, 2002). Moreover, HR reactivity has shown to be less significantly impacted by mood states in alcohol users, since it is not correlated with levels of sadness, distress or irritation after negative mood induction (Jansma et al., 2000). Therefore, personal dilemmas should induce HR decreases in normal controls, but in agreement with the somatic-marker theory of addiction and the dual-process model of moral decision-making, this response may be attenuated in alcohol-dependent individuals.

In addition to examine HR responses to moral dilemmas, we also explored whether the emotional deficits proposed to relate to utilitarian choices were associated with general physiological deficits in baseline conditions, when no task is present. In particular, Heart Rate Variability (HRV), and especially Respiratory Sinus Arrhythmia (RSA), have been demonstrated to be reliable indices of emotional regulation (Thayer and Lane, 2000). Reduced HRV-RSA is interpreted as a physiological correlate of deficient generation of emotional responses (Appelhans and Luecken, 2006; Thayer and Lane, 2000). In its neuro-visceral integration model, Thayer and Lane interpreted HRV (especially vagal-mediated high frequency or RSA) as an index of attentional-emotional regulation related to tonic inhibitory influences from the prefrontal cortex to subcortical structures. The reduced HRV is then interpreted as a dysregulation of this inhibitory network. This would suggest lower effects of emotion on regulation of cognitive processing, and may therefore be relevant for moral decision-making. In particular we propose that individuals with lower HRV would be more reluctant to consider moral infractions as acceptable behaviors than those with higher HRV. Accordingly, previous evidence has shown that variations in baseline HRV or RSA are associated with performance in emotion regulation and cognitive control tasks (Lane et al., 2001; Thayer et al., 2009; Thayer and Lane, 2000) and with adequate integration of prefrontal-subcortical systems in the linkage between peripheral physiology and cognitive control (Thayer et al., 2012).

In summary, this study is aimed to test whether autonomic nervous system responses to moral dilemmas indexed by heart rate contribute to explain utilitarian choice patterns in alcohol-dependent individuals. We hypothesized that alcohol dependent individuals would display: (i) reduced cardiac reactivity to the moral dilemmas, specifically a less pronounced HR deceleration during personal moral dilemmas, and (ii) reduced RSA at baseline, which would correlate with more utilitarian choices in personal dilemmas.

2. Methods

2.1. Participants

Thirty-one alcohol-dependent individuals and 34 non-alcohol using controls participated in this study. This sample overlaps with that presented in another study, which tested behavioral choice in response to moral dilemmas. Alcohol-dependent individuals were recruited as they commenced psychosocial treatment

at the Addicted Behaviors Unit of Nostra Senyora de Meritxell Hospital (Andorra). We initially screened 43 participants between October 2010 and June 2011. Of them, we excluded 9 participants because they did not meet inclusion criteria. The inclusion criteria were defined as follows: (i) meeting DSM-IV criteria for alcohol dependence; (ii) absence of comorbid dependence of other drugs (excluding nicotine); (iii) maintained abstinence at least 15 days before testing, confirmed by twice weekly urine analyses; (iv) not having history of head injury or neurological disorders; (v) not having current comorbid diagnoses of Axis I or Axis II disorders, assessed by clinical reports; and (vi) the absence of severe cognitive impairments caused by dementia. Compliance with inclusion criteria was assessed using the Structured Clinical Interview for DSM-IV (SCID-I; First, 2007) to diagnose alcohol dependence and exclude any other substance dependence disorder. All participants also completed the Millon Clinical Multiaxial Inventory III (MCMI-III; Millon and Davis, 1997) and the Symptom Check List, Revised (SCL-90-R; Derogatis, 1977) to provide information on personality disorders and psychopathological symptoms. To screen the presence of severe cognitive impairment we used Mental State Examination (MMSE, Folstein et al., 1975; Spanish version from Lobo et al., 1979), excluding participants who rated below normal baseline score (27; Folstein et al., 1975). Data regarding patterns of quantity and duration of drugs use, including typical amount per month, duration of use and total alcohol consumption (lifetime amount), was collected using the Interview for Research on Addictive Behavior (IRAB; Verdejo-García et al., 2005).

Controls were recruited through snowball communication among adults from the same geographical area as patients, during the same period of time. Additional selection criteria for control participants was the absence of current or past diagnoses of substance abuse or dependence, excluding past or current social drinking (less than ten standard units per week) and nicotine. Four control participants were excluded due to alcohol abuse and one participant due to cannabis use. For technical reasons HR-data were not available for three participants from the control group; Also, HRV were not available for three controls and three alcohol-dependents.

Alcohol-dependent individuals and controls did not differ on sex and ethnicity (all participants were European-Caucasian males). The groups also did not differ significantly in terms of age [mean \pm standard deviation (SD)]; alcohol-dependents 52.06 ± 6.48 ; controls 48.77 ± 10.66 ; $p = 0.141$], handedness (alcohol dependents 87.1% right handed and 12.9% left handed; controls 88.2% and 11.8%, respectively; $p = 0.889$) and socioeconomic level (64.5% of alcohol-dependents and 70.6% of controls had middle socioeconomic status, $p = 0.492$). The groups differed in years of education [alcohol dependents 13.74 ± 1.98 ; controls 17.12 ± 2.75 ; $p < 0.001$], and therefore this variable was included as a covariate in all subsequent analyses.

In the alcohol-dependent group, the mean amount of alcohol use was 565.80 (SD = 462.26) units/month, the mean duration of alcohol consumption was 26.50 (SD = 8.53) years, and the mean duration of abstinence was 11.02 weeks (SD = 14.95). Duration of abstinence did not influence on the psychophysiological concomitants to moral judgments, since it was not correlated with HR ($r = 0.30$, $p = 0.116$), nor HRV ($r = -0.27$, $p = 0.161$). In the control group, the mean alcohol use was 21.38 (SD = 12.50) units/month and the mean duration of any alcohol use was 20.66 (9.67) years (note that this figure merely reflects time since first alcohol use). From these data, we calculated the main parameter of total lifetime alcohol consumption (the product of mean amount \times duration). Total alcohol consumption in the alcohol-dependent group was of 188027 units/lifetime (SD = 167377), and in controls was of 5077 units/lifetime (SD = 4359).

2.2. Instruments and procedure

This study was conducted according to the principles expressed in the Declaration of Helsinki. The protocol assessment was approved by the Ethics Committee for Human Research of the University of Granada and the Ethics Committee for Clinical Research of Nostra Senyora de Meritxell Hospital. All participants signed an informed consent before testing. The assessment was conducted individually in two sessions that lasted approximately 1 h each. In the first session, participants were administered the clinical measures of addictive behavior, other psychiatric disorders and cognitive impairment. The moral decision-making task was administered in a second session. The instruments included in this research belong to a more extensive evaluation protocol aimed at studying neuropsychological functions in alcoholism.

Moral decision-making was evaluated by 32 hypothetical dilemmas selected by Rasch analyses from Greene's moral dilemmas (Greene et al., 2001). The battery of dilemmas was adapted to Spanish language through a back-translation procedure, and its psychometric properties were tested in an independent community sample and found to be satisfactory (Cronbach's $\alpha = 0.78$, Spearman Brown coefficient = 0.76; Carmona-Perera et al., under review). In agreement with previous studies, we used four categories of dilemmas: non-moral dilemmas (involve non-moral decisions, e.g., buy a new camera or to have your old camera repaired for the same price; $n = 8$), impersonal moral dilemmas (involve non-emotional salient moral decisions, e.g., to turn a trolley away from five people, but toward one person; $n = 8$), and personal moral dilemmas (involve emotional salient moral decisions; $n = 16$), which were further divided into low-conflict, easy dilemmas (characterized by shorter decision latencies and high inter-subject response agreement, e.g., push a person off a bridge to stop a trolley from hitting five people), and high-conflict, more difficult dilemmas (characterized by longer decision latencies and lower levels of response agreement, e.g., smothering a baby to save a group people; Koehnig

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