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Habituation in acoustic startle reflex: Individual differences in personality

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ABSTRACT

This study analyzed the relationship of individual differences in personality with habituation in the acoustic startle response (ASR). Data from nine trials in ASR to white noise bursts and a personality questionnaire based on the alternative big five personality approach were modelled with a latent growth curve (LCM) including intercept and slope habituation growth factors. There was a negative correlation between the intercept and slope, indicating that individuals with higher initial ASR levels had also a more pronounced and faster decrease in the ASR. Contrary to expectations, Extraversion and Sensation Seeking did not relate with habituation in ASR. Neuroticism and Aggressiveness related asymmetrically with the habituation rate in ASR. Higher levels of Neuroticism were related with faster habituation, whereas higher levels of Aggressiveness were related with slower habituation. Further studies with the LCM should be undertaken to clarify in a greater extent the association of personality with habituation in ASR.

1. Introduction

Habituation is an intriguing and complex process. As an elementary form of learning, it takes place at the neural level, and implies a progressive decrement in a given response issued after a repeated stimulation. The dual-process theory is the most influential systematization of this phenomenon, with the key assumption of two intertwined processes in the central nervous system: habituation (decline of the response), and sensitization (intensification of the response). There are two important stimulus parameters, intensity and frequency, that influence both processes in different ways. Higher intensity levels tend to rule sensitization, whereas higher frequencies influence habituation in a greater extent. Within this framework, it is also useful to distinguish between short-term habituation, a decay of the response in the same experimental session, and long-term habituation, a decay of the response between different experimental sessions (Groves and Thompson, 1970; Thompson and Spencer, 1966).

Later refinements about habituation have suggested that the identification of influential pathways might be of use to clarify the cellular and neuronal mechanisms embedded within the habituation processes (Rankin et al., 2009; Thompson, 2009). On the other hand, a psychological constructionist approach to human emotion advocates for the fact that biological explanations of behaviour such as brain activity, chemical circuitries, or synaptic connections should not replace the psychological accounts for the wide array of mental experiences. Albeit physiological attributes are certainly important elements in the configuration of emotion and mental states, they would not be specific for instance to emotions such as interest, happiness, sadness, anger, disgust, or fear (Barrett et al., 2007; Miller, 2010). Recent evidence from the neuroimaging literature supports this psychological constructionist scheme in contrast to a locationist approach, which defends the correspondence of emotion categories with different brain regions (Lindquist and Barrett, 2012; Lindquist et al., 2012). Thus, complex psychological descriptors might be outlined at a strongly wired network level, suggesting that emotion categories would emerge from non-specific general brain systems. Nevertheless, it has also been argued that neuroimaging studies tend to manage the effects of individual differences as noise that needs to be dealt with because of the emphasis on brain activation arrangements assumed as common across individuals (Hamann and Harenski, 2004; Murphy et al., 2012). Moreover, the association of specific brain activation with emotional and cognitive processing has been suggested to be strongly leveraged by individual differences such as personality, mood, dispositional affect, sex, and genotype, whereby these would be important modulators of the neurobiological basis of emotion and cognition (Canli et al., 2004; Hamann and Canli, 2004).

Bearing this in mind, habituation in responses to emotional and cognitive processing is a neurobiological process influenced by individual differences in personality, despite the paucity of studies addressing this particular topic. In this work, we analyzed the association of habituation in acoustic startle reflex (ASR) and broad personality dimensions with a latent curve model (LCM). At present, there are only a few studies

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addressing the interrelationship of habituation in ASR, and to the best of our knowledge, only one study has employed the LCM. More specifically, there are at least three main interrelated substantial reasons why this is a meaningful topic of study. First, habituation might be a core mechanism underlying the biological background in personality insofar as there are in fact noticeable individual differences in habituation processes. Thus, studying its relationship with personality may contribute to a better understanding of the biology and psychophysiological aspects of personality. Second, startle habituation has been considered as a basis for judgement and consideration of impairments in several functions such as motor or cognitive responses. Including personality measures in both, basic and applied studies about ASR and its habituation phenomenon may be more informative and particularly useful in the study of mental disorders because of their links with extreme scores in personality variables. Finally, there is a wealth of studies about the ASR, although little consideration has been given to the startle habituation blocks usually presented before the experimental part, due in part to the diversity of methods used to calibrate the habituation process. The proposed method to study the habituation portion in ASR studies, the LCM, has been previously applied to study gender differences (Lane et al., 2013). The present study addresses however the role of broad personality factors in this neurobiological process.

1.1. Characterization of habituation

There is an extensive amount of literature using different methods to portray habituation responses. However, not all of them allow for an easy accommodation of personality traits to determine whether they relate or not with habituation. A common approach consists in adding up single habituation trials into a fewer amount of sections or blocks, and then compare the habituation means amongst the different blocks (Blumenthal, 2001; Blumenthal et al., 1995; Bradley et al., 1993). Furthermore, regression-based methods attempt to define some sort of habituation function and then correlating the habituation parameters of interest with personality measures, apply the particular model to subgroups of individuals, or contrast the model outcomes with real habituation data (Alonso et al., 2005; Gilmore and Thomas, 2002; LaRowe et al., 2006). The calibration of habituation has also been addressed from computational models mainly based in neural networks. Within this approach, habituation is assumed as a synaptic-like scheme aimed to explain some type of subsequent behaviour (Marsland, 2009; Sirois and Mareschal, 2002; Wang, 1994; West and Grigolini, 2010). The latent curve model (LCM) is a more novel approach that has been recently recommended to tap habituation (Lane et al., 2013). The variance–covariance matrix and mean vector of the habituation trials in a given experiment are used to estimate a latent underlying trajectory. The intercept and slope factors define the change in this trajectory by representing the initial level and habituation rate of the studied process, respectively. Hence, apart from allowing estimating the magnitude and direction of habituation initial level and growth rate, it is possible to compare these parameters amongst different groups of individuals, or predict the habituation process with exogenous variables.

1.2. Habituation and individual differences in personality

The pathways by which different personality dimensions might relate with habituation remain largely unclear with only a small amount of research works addressing this topic. Some studies have explored the association of different habituation scenarios with personality traits in open-field investigations with non-human subjects (Ellenberg et al., 2009; Martin and Réale, 2008; Rodríguez-Prieto et al., 2011). Moreover, research with humans such as patients with schizophrenia (Akdag et al., 2003; Mason et al., 1997), the general healthy population (Martin-Soelch et al., 2006), or undergraduate students (Anderson et al., 2011; Blumenthal, 2001; LaRowe et al., 2006) suggest that habituation could be associated with individual differences in personality traits.

Most of these studies have relied on the biological foundations of personality (Eysenck, 1994; Gray, 1987; Zuckerman, 2005). In accordance with the Eysenck's theory, Extraversion and Neuroticism relate with the cortical and limbic brain systems, respectively. The cortical system deals with the arousal tone elicited by input stimuli, the limbic system with the response and/or regulation of emotional states. Higher scorers in Extraversion would have a lower level of arousal in the ascending reticular activation system (ARAS) in contrast with lower scorers in Extraversion who would display a higher level of arousal. Besides, higher scorers in Neuroticism would be more sensitive to emotions and more prone to anxiety and agitation, in contrast with lower scorers in Neuroticism who would be less arousing and more prone to steadiness under stressful conditions. Gray's theory in turn suggests impulsivity and anxiety as juxtaposed to Eysenck's Extraversion and Neuroticism, and associated with the behavioural activation and inhibition systems (BAS and BIS). The BAS and BIS are thought to be sensitive to signals of either reward or punishment, respectively, and relate with different brain structures connected with either approaching or inhibiting behaviours. Finally, the alternative five model postulated by Zuckerman focusses on the explanation of personality from evolutionary psychology. This model subsumes four major personality dimensions currently found across different personality frameworks plus an activity factor: Extraversion/sociability, Neuroticism/anxiety, constraint vs impulsive Sensation Seeking, and aggression/hostility vs agreeableness.

Extraversion and Neuroticism are the two central personality dimensions addressed in greater depth when analyzing habituation in psychophysiological responses. Overall, it has been suggested that the lower cortical activation level in extroverts would lead them to faster habituation rates than introverts, whereas the higher sensitivity to emotions of higher scorers compared with lower scorers in Neuroticism might relate with abnormally slower habituation rates (Cook et al., 1991; Eysenck, 1994; LaRowe et al., 2006; Larsen and Ketelaar, 1991). Nevertheless, slower habituation rates in electrodermal activity for high sensation seekers (De Pascalis et al., 2007), and low trait anxious subjects (Wilken et al., 2000) have also been reported. Pioneering research about personality and habituation was mostly focussed on electroencephalography (EEG) and electrodermal response (EDR), and critically scrutinized theoretical and methodological grounds (O'Gorman, 1977; Smith et al., 1990). Habituation in the acoustic startle response (ASR) and its potential relationship with personality have been studied in a much lesser extent.

1.3. Habituation in acoustic startle response (ASR) and personality

The ASR refers to a quick contraction of the *orbicularis oculi* muscle which closes the eye and happens at about 30–50 ms after the onset of an auditory stimulus. The ASR has been broadly used to study the neuronal, emotional, and cognitive basis of sensor motor responses and information processing (Blumenthal et al., 2005; Filion et al., 1998; Lang et al., 1990). Nevertheless, although habituation might have the capability to modulate ASR (Bradley et al., 1993; Koch, 1999), it has also been argued that the eye blink component might not habituate likewise the rest of the startle response (Carlsen et al., 2011). As far as we know, there is no research about habituation and personality with the LCM approach. The present study relies on this method because it provides a useful framework to study patterns of change in ASR habituation, and more importantly, the exploration of the potential links of habituation in ASR with individual differences in personality. Moreover, no research works have analyzed the association of personality as measured with the broad dimensions derived from the Zuckerman's alternative big five model (Zuckerman, 2005) with habituation in ASR. The aim of this study was therefore, to evaluate whether these personality broad dimensions were related with growth trajectories in ASR as gauged by a LCM.