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Gender differences in personality and heart-rate variability

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ABSTRACT

Both personality traits and autonomic functioning show as gender differences, but their relationship is not well understood. Medically unexplained symptoms are related to personality features and can be assessed by autonomic measurement. The patterns are hypothesised to identify gender differences. We recruited 30 male and 30 female healthy volunteers. All participants completed the Tridimensional Personality Questionnaire (TPQ) and heart-rate variability (HRV) measurement. Correlation analysis was performed to identify the relationships between TPQ scores and HRV parameters. For the subjects as a whole, the subdimension harm avoidance 4 (HA4, fatigability and asthenia) was found to be negatively correlated with low-frequency (LF) power, high-frequency (HF) power and total power (TP) of HRV. Novelty seeking 1 (NS1, exploratory excitability) was found to be positively correlated with LF power and TP. Multiple linear regression analysis revealed that the interactions exploratory excitability *x* gender and fatigability *x* gender are predictors of LF and HF power, respectively. Our result supports the hypothesis that personality features such as exploratory excitability and fatigability are associated with autonomic functioning and that gender is a moderator in these relationships.

1. Introduction

Medically unexplained symptoms (MUSs), such as fatigue, generalised soreness, poor digestion, dizziness, headache and chest discomfort, are common among psychiatric patients (Hsu and Folstein, 1997). In Asian culture among the general public, this phenomenon is often called 'neurasthenia' and is believed to be caused by autonomic nervous system (ANS) dysfunction (Schwartz, 2002). Neurasthenia is similar to chronic fatigue syndrome as defined by the United States Centers for Disease Control and Prevention (Farmer et al., 1995). The relation between ANS dysregulation and chronic fatigue syndrome has been found in several studies (Freeman, 2002; Freeman and Komaroff, 1997; Jones et al., 2010; Pagani and Lucini, 1999; Stewart, 2000). Personality traits such as anxiety, pessimism and impulsiveness are associated with MUSs and chronic fatigue syndrome (Fischler et al., 1997; Jiang et al., 2003; Russo et al., 1994). The personality features of chronic fatigue syndrome in men and women are different. Males show more psychological worry about health and more fear about physiological breakdown (Miller-Iger, 1992). Whether gender plays a role in the relations between MUSs and ANS remains unexplored.

ANS functioning can be quantitatively measured by heart-rate variability (HRV) because the heart rate is affected by both sympathetic and parasympathetic systems (Kuo et al., 2005; Malliani et al., 1991a; Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). In frequency domain analysis, high-frequency (HF) power reflects parasympathetic modulation, while sympathetic function can be estimated by normalised low-frequency power (LF%) and ratio of LF power to HF power (LF/HF) (Kuo et al., 1999; Malliani et al., 1991b). Currently, a standardised 5-min measurement of HRV is widely used (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). This provides a non-invasive, easily applied and acceptable method to investigate ANS function.

Research studies focussing on personality traits and HRV are relatively few. Nonetheless, it is noticeable that this limited number of studies shows similar findings, namely that HF power is negatively correlated with the anxiety trait, neuroticism or HA (Bleil et al., 2008; Dishman et al., 2000; Ode et al., 2010). However, which aspect of the anxiety trait spectrum has the

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highest correlation with HRV is yet to be determined. For example, the Tridimensional Personality Questionnaire (TPQ), a commonly used self-administered tool for evaluating temperament, has four subdimensions that fall under the major dimension of HA (a construct positively associated with neuroticism) (De Fruyt et al., 2000). HA4, the trait of fatigability and asthenia, is related to chronic fatigue syndrome (Van Campen et al., 2009). One possible cause of high fatigability is that individual's heart or circulatory system does not work well (Furlan et al., 2000; Knutsson and Boggild, 2000). Therefore, we hypothesise that this fatigability score may make the greatest contribution to the negative correlation between HA and HF power. In addition, the relation between other personality features and autonomic system remains worthy of investigation. For example, sensation seeking (a property related to the construct of extraversion) has been found to be associated with the sympathetic arousal (Aluja et al., 2003; Smith et al., 1990; Zuckerman, 1990). High sensation seekers reveal upregulated dopaminergic but downregulated serotonergic system (Zuckerman, 1993). It may be better understood by analysing the correlation between HRV and TPQ.

Gender differences in HRV have been found in previous studies (Kuo et al., 1999). Middle-aged men show higher LF% and lower HF power than middle-aged women, which implies that males show sympathetic predominance, while females show vagal predominance. Such a difference explains the fact that there is a higher risk of cardiovascular disease among men and suggests that the ANS balance might be affected by sex hormones (Du et al., 1994; Vanoli et al., 1991). Higher HA or trait anxiety scores among females have been reported previously (Chen et al., 2002). Gender differences in sensation seeking are also known to exist (Zuckerman et al., 1990). Neuroendocrine and autonomic hypotheses to explain this have been proposed but there is a lack of clear evidence (Kelly et al., 2008). It is possible that fatigability or other personality dimensions for the two genders may originate from different ANS components. The viewpoint can be examined by investigating the relationship between the gender–personality interaction and HRV.

Taking the above into account, we consider that high fatigability is likely to be a trait consistent with MUSs (or an attenuated presentation of MUSs) and that it originates from a long-term ANS imbalance. In addition to this, since MUSs and ANS function are both found to have gender differences, it is possible that gender acts as a moderating factor of the above relationship, namely that fatigability in females is also influenced by the menstrual cycle or by female sex hormone levels; in such circumstances fatigability cannot be estimated only from the ANS perspective. MUSs are not easy to define and therefore it is relatively difficult to analyse the association between MUSs and ANS function directly. Therefore, the present study explores the relationship between fatigability and HRV in healthy subjects.

The study design is based on the following hypotheses: (a) there is a meaningful correlation between the personality feature fatigability and ANS functioning; (b) the relationship between personality traits and ANS may show gender differences and that these originate from divergences in the pattern of sympathovagal balance between men and women; and (c) in healthy subjects, the influence of psychological state on HRV is less than the influence of personality.

2. Methods and Materials

2.1. Participants

This study programme was approved by the Institutional Review Board of National Taiwan University Hospital (NTUH), Yun-Lin Branch, in Taiwan. By posting advertisement in the community and on a webpage, we recruited 30 male and 30 female healthy adults from within the hospital local area. The age of the subjects was between 25 and 60 years and the study was designed to include participants with a stable personality and few, if any, physical illnesses. Subjects with psychiatric disorders, cardiovascular disease and diabetes mellitus, who were using alcohol or illicit substances and who were using psychiatric/cardiovascular medication, were excluded. After obtaining informed consent, a subject spent about 1 h completing all the questionnaires and undergoing HRV measurement. All data obtained from a subject was gathered in 1 day and the HRV assessment was always performed in the morning (9 am to 12 pm). In the section recording demographic data, factors known to affect HRV, such as age, smoking, baseline blood pressure, body mass index (BMI) and exercise level were recorded (Faulkner et al., 2005; Rajendra Acharya et al., 2006). Blood pressure, body weight and body height were measured before performing the HRV, while exercise level was estimated via a self-rating questionnaire.

2.2. Measurements

Three validated questionnaires were used in the presented study. The TPQ was chosen to evaluate the individual's persistent personality traits, which is our major analysis target. The Beck Depression Inventory (BDI) and the State and Trait Anxiety Inventory (STAI) were administered to clarify various influences on the subject's current psychological state.

TPQ, a self-administered questionnaire with 100 true–false questions, was developed by Cloninger in 1986 (Cloninger et al., 1991). It is designed to measure innate and biological component of personality. TPQ has three major dimensions, which are novelty seeking (NS), HA and reward dependence (RD). Each major dimension has four subdimensions. NS consists of NS1 (exploratory excitability), NS2 (impulsivity), NS3 (extravagance) and NS4 (disorderliness). HA is composed of HA1 (anticipatory worry), HA2 (fear of uncertainty), HA3 (shyness with strangers) and HA4 (fatigability and asthenia). RD consists of RD1 (sentimentality), RD3 (attachment) and RD4 (dependence). RD2 (persistence) is considered to be an independent concept to other RD subdimensions and usually not summated into RD total score. The Chinese version used in our study was translated by Chen et al. (2002).

An individual's current state of anxiety and depression is known to affect HRV (Francis et al., 2009) and therefore we used the BDI and STAI to measure these two psychological factors. BDI is a self-report inventory with 21 multiple-choice questions that measures both the cognitive and the vegetative symptoms of depression (Shek, 1990). STAI, which measures both anxiety state and anxiety trait, is an inventory that uses a four-point Likert scale (Shek, 1993). The Chinese version of STAI that was adopted in this study was developed by Chung et al. in 1984 (Chung and Long, 1984). The relationship between these two inventories and HRV was also analysed.

2.3. Heart-Rate Variability

A standardised 5-min measurement of HRV was used in this study. The procedure corresponded to the guidelines presented in Circulation, 1996 (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). Subjects were asked to sit in a relaxed position but not to fall asleep. Their body temperature and respiratory rate were noted as being within the normal range. We used an HRV analyser (SS1C, Enjoy Research Inc., Taiwan) for electrocardiogram (ECG) signal acquisition, storage and processing. An 8-bit analogue-to-digital converter with a sampling rate of 512 Hz was used to record signals. The digitised ECG signals were analysed online and simultaneously stored on a hard disk for offline verification. The computer algorithm then recognised each QRS complex (the QRS wave in ECG) and rejected ventricular premature Complex or noise based on likelihood using a standard QRS template. We resampled and interpolated normal and stationary R–R interval values at a rate of 7.11 Hz to produce continuity in the time domain. A total of 2048 data points over 288 s were produced by the interpolation and these were then used for the subsequent Fourier transformation.

The frequency domain analysis of HRV (rather than time domain, non-linear analysis) was chosen in this study because it was widely used in the psychiatric field (Carney et al., 2001; Kemp et al., 2010). Power spectral analysis was carried out by fast Fourier transformation. After deleting baseline shift, a Hamming window was used to attenuate the leakage effect. Our algorithm estimated the power spectrum density for each time segment (2048 data points, in 288 s). The power spectrum was subsequently quantified into the standard frequency-domain measurements, including HF power (between 0.15 and 0.4 Hz), LF power (between 0.04 and 0.15 Hz), very-low-frequency (VLF) power (between 0.003 and 0.04 Hz), total power (TP), normalised LF (LF%) and LF/HF (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). LF% was calculated from LF/(total power − VLF) × 100. The final results for LF, HF, TP and LF/HF underwent natural logarithmic transformation to correct for their skewed distributions. In our study, the major HRV parameters used as observations were LF, HF, TP, LF% and LF/HF.