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Orthostatic cardiovascular profile of subjective well-being

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ABSTRACT

Previous clinical and elderly population studies have found that affective well-being can be assessed by clino-orthostatic cardiovascular reactivity. This study explored this relationship in a young healthy sample, and with respect to cognitive appraisals of well-being. Four successive readings of blood pressure (BP) and heart rate (HR) after lying down (clinostatic probe) followed by four successive readings after standing up (orthostatic probe) were obtained from 52 healthy students along with questionnaire-reported well-being. Analyses indicated that a deeper drop of systolic BP (SBP) and mean arterial (MAP) pressure during supine was related to higher positive mood, but higher and more stable orthostatic MAP and HR response were related to lower negative mood. A higher diastolic BP while standing upright and lower SBP in general were associated with higher optimism and higher global life satisfaction, respectively. The findings confirm previous results and indicate that cognitive appraisals of well-being are also related to BP regulation.

1. Introduction

People can maintain their emotional and cognitive well-being in the face of acute or chronic challenges, and this ability is defined as resilience (Davydov, Shapiro, & Goldstein, 2010; Davydov, Stewart, Ritchie, & Chaudieu, 2010, Davydov, Stewart, Ritchie, & Chaudieu, 2012). These studies have indicated that the main challenge is to objectively identify the resilience profile the individual uses in coping with events and to estimate its effectiveness and efficiency. It is especially important when subjective estimates of well-being are concerned or challenged (Davydov & Perlo, 2015; Perlo & Davydov, 2016).

Previous studies found that estimates of cardiovascular (CV) reactivity in response to clinostatic probe (i.e., CV response to posture change from standing to lying) and to orthostatic challenge (i.e., CV response to posture change from lying to standing) can be used to measure or predict resilience (Davydov et al., 2015; Davydov & Perlo, 2015; Davydov, Stewart et al., 2010, 2012). Deeper decreases of blood pressure (BP) and heart rate (HR) levels after lying down as a response to either clinostatic probe or regular supine rest is suggested to be an autonomic indicator of effective inhibition of central arousal level coupled with better somatic and affective well-being, which may be altered (e.g., clinostatic hypertension and nighttime non-dipping BP) in some somatic and mental disorders (Davydov et al., 2015; Davydov, Shapiro et al., 2010; Davydov, Stewart et al., 2010, 2012; Fagard & De Cort, 2010; Lagi & Spini, 2010). In contrast, a higher and stabilized physiological arousal while upright is crucial for human well being, as the erect position is required for successful functioning and coping with most physical, mental, and social events of human life (Davydov, Stewart et al., 2010, 2012). In some pathological conditions (e.g., diabetes, chronic kidney, CV and blood diseases, chronic pain, and mental disorders), the orthostatic response may be altered in magnitude and stability (e.g., HR and BP may respond with lower means and higher variance) (Davydov et al., 2015; Davydov & Perlo, 2015; Davydov, Stewart et al., 2012; Fagard & De Cort, 2010; Franceschini, Rose, Astor, Couper, & Vupputuri, 2010; Maule et al., 2007). In contrast, an elevated orthostatic BP response in a large prospective study was found to be an objective indicator of protection of subjective well-being against a dispositionally high negative mood level of an individual after aversive events and a predictor of the increase in positive mood in follow-up (Davydov, Stewart et al., 2012). Moreover, the increase of CV response to orthostatic challenge achieved

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by conditional biobehavioral training was found to improve indicators of health and well-being (Davydov, 2011, 2013; Reybrouck, Heidbüchel, Van de Werf, & Ector, 2000; Tan et al., 2010).

Orthostatic challenge is a gravity-induced biological challenge (blood volume movement from upper to lower body parts) that triggers several successive evolutionary-developed counteracting, adaptive and resilient physiological processes (Davydov, 2013; Davydov et al., 2015; Davydov & Perlo, 2015). Orthostatic response integrates several compensatory processes that can be detected in a relatively short period of time through their trends (Oparil, Vassaux, Sanders, & Haber, 1970). Postural change to upright standing requires the cooperation of a rapid and effective pump of the skeletal muscles of the lower extremities (rhythmic cycles of contraction and relaxation) and successive neurocardiac, neurovascular, and neurohumoral processes[1] to maintain adequate and stable BP level (providing general arousal regulation), perfect cerebral perfusion (providing central arousal regulation), and clear consciousness (providing alertness and decision making). When a single mechanism fails and reacts with under- or overfunctioning, others may partially compensate for it by overfunctioning ('up rebound' feedback) or underfunctioning ('down rebound' feedback) (e.g., a greater increase in HR with a weaker tone or pump function of antigravity muscles (Stewart, Medow, Montgomery, & McLeod, 2004)).

Although previous studies found relationships between subjective well-being and CV responses to orthostatic challenge (Davydov, Stewart, et al., 2012; Richardson et al., 2009; Vasudev, O'Brien, Tan, Parry, & Thomas, 2011), they assessed the relationship only in elderly and clinical populations and mainly with respect to affective estimates of well-being. However, besides the affective components (positive and negative moods and emotions), subjective well-being includes cognitive components (e.g., optimism and life satisfaction) that are related, but differ in their temporal stability (short- or long-term well-being associated with affective or cognitive components, respectively), predictors, and consequences that may be indicated in physiological processes (Blanchflower & Oswald, 2008; Davydov & Perlo, 2015; Diener & Chan, 2011; Luhmann, Hawkley, Eid, & Cacioppo, 2012; Mojon-Azzi & Sousa-Poza, 2011; Räikkönen & Matthews, 2008).

Optimism is defined as positive dispositional expectations (persistently positive thoughts, beliefs or forecasts) for the future (Segerstrom, 2005). Its high level may protect subject's health against short-lasting (for about a week) or (either actually or perceivably) controlled stressors, but may increase risk for disease if stressors persist or are uncontrolled. Mood did not account for these optimism effects, and optimism has been shown to be regulated by an engagement (problem-solving, goal pursuit, and achievement striving) mechanism in the face of stressors (Räikkönen, Matthews, Flory, Owens, & Gump, 1999; Segerstrom, 2005). This mechanism is associated with conscientiousness and is primarily cognitive and motivational (Segerstrom, Castañeda, & Spencer, 2003). However, optimism may potentially overlap with cognitive factors of depression such as hopelessness and pessimism (the inverse of optimism). Optimism/pessimism was correlated with diastolic BP (DBP) reactivity and daytime ambulatory DBP (Räikkönen & Matthews, 2008; Räikkönen et al., 1999; Williams, Riels, & Roper, 1990) and was expected to be correlated with DBP level in standing posture in the present study as a proxy of daytime DBP level (Fagard & De Cort, 2010).

Global life satisfaction is another component of subjective well-being representing a cognitive global evaluation of the quality of one's life as a whole that is not generally associated with current mood and is also distinct from emotional well-being in its effects on various external variables (Diener, Emmons, Larsen, & Griffin, 1985; Diener, Inglehart, & Tay, 2013; Lucas, Diener, & Suh, 1996; Luhmann et al., 2012; Pavot & Diener, 2008). This component showed considerable stability over several years and is related to appraisals of past events and experiences as good or bad. These subjective appraisals can depart from reality in some way (i.e., over- or under-estimate experiences as good or bad), but these cognitive biases in some instances can be helpful to adaptive functioning. Previous studies showed that global life satisfaction was negatively correlated with hypertension or high BP problem in general (Mojon-Azzi & Sousa-Poza, 2011) and was expected to have the same correlation with average means of systolic BP (SBP) and/or DBP in the present study of healthy subjects.

Previously, in healthy subjects lower SBP dipping during nighttime sleeping as a proxy for the supine posture, i.e., low arousal condition (Fagard & De Cort, 2010) was associated with higher affective well-being (higher positive mood) (Davydov, Shapiro et al., 2010). Another study in chronically stressed people showed that a negative affect could increase fluctuation of SBP in standing posture (a higher arousal condition) (Davydov & Perlo, 2015). The same study found that higher orthostatic HR response was associated with a stronger protection mechanism against a functional and psychosocial disability from chronic stress, lasting for years, i.e., against long-term exposure or disposition to negative moods or stressful environments (Davydov & Perlo, 2015). This later mechanism was considered to have a weaker effect size to be detected in the planned sample of healthy subjects relatively homogeneous in individual fitness to living environments, i.e., the main component modulating the inherited vagus-related protection mechanism indicated by orthostatic HR response (Davydov et al., 2015). Accordingly, in the present study, (i) a negative correlation was expected between positive mood as a component of affective well-being and supine SBP and (ii) another negative association was predicted between negative mood as another indicator of affective well-being and a SBP stability in standing posture.

Thus, the aim of the present study was to confirm two hypotheses that (i) in young healthy subjects more decrease of BP during the lying posture (i.e., more effective state-related inhibition of physiological arousal) and more stable BP during standing posture (i.e., more effective state-related activation of physiological arousal) are also associated with better affective well-being assessed by high positive and low negative moods, respectively, but (ii) cognitive well-being measures (optimism and life satisfaction) are related to regulation of more persistent physiological arousal (e.g., average means of SBP and DBP).

[1] A time-related profile (i.e., trend) of autonomic and humoral responses to orthostatic challenge can indicate a successful (effective) or impaired (ineffective) condition of the baroreflex and extra-baroreflex mechanisms regulating mind and body functioning at different stages during transitions between steady-state supine and standing positions (Edgell, Robertson, & Hughson, 2012; Oparil et al., 1970): (i) early response of heart rate (HR) with a steady state adapted to standing (i.e., reaching its plateau) after 1 min (the cardiac baroreflex) – HR normally increases by approximately 1.5 times (Cooke et al., 1999; Goldstein, Naliboff, Shapiro, & Frank, 1988; Heldt, Shim, Kamm, & Mark, 2002); (ii) mid-response of the sympathetic nerves (SNA) with associated plasma norepinephrine (NE) increase with a steady state of its activity adapted to standing after 2–3 min with corresponding (almost non-delayed) effect on vascular resistance (the vascular baroreflex) – SNA, NE, and vascular resistance normally increase by about 1.5–2 times (Cooper & Hainsworth, 2001; Kamiya, Kawada, Mizuno, Shimizu, & Sugimachi, 2010; Yoshinari et al., 2001; Young, Rowe, Pallotta, Sparrow, & Landsberg, 1980); (iii) late response of sympathetic renal nerve (SRN), which activity is released (de-inhibited) due to baroreceptor modulation effect (a steady state adapted to standing after 3 min), with successive SRN effect on delayed humoral response of the renin-angiotensin-aldosterone system (the 'renal' baroreflex) – renin activity normally increases after 3-min of standing by about 1.25 times and stabilizes (plateaus) after 20 min at the level by about 3 times the supine level (Jacob et al., 1998; Oparil et al., 1970; Yoshinari et al., 2001). These changes return to baseline after changing posture from standing to supine with almost the similar order of autonomic responses.