Physiology & Behavior 143 (2015) 83–89

Contents lists available at ScienceDirect

Physiology & Behavior

journal homepage: www.elsevier.com/locate/phb

Reduced cerebral and cardiovascular hemodynamics during sustained affective stimulation in young women with chronic low blood pressure

Nicola Cellini [a,*], Massimiliano de Zambotti [a,b], Naima Covassin [a,c], Germano Gallicchio [a], Luciano Stegagno [a], Michela Sarlo [a,d]

[a] Department of General Psychology, University of Padova, Italy
[b] Center for Health Sciences, SRI International, Menlo Park, CA, USA
[c] Mayo Clinic, Department of Internal Medicine, Division of Cardiovascular Diseases, USA
[d] Center for Cognitive Neuroscience, University of Padova, Italy

HIGHLIGHTS

- We assessed emotional reactivity in hypotensive and normotensive women.
- Hypotensives exhibited blunted hemodynamic responses to emotional stimulation.
- Hypotensives showed reduced emotional processing of pleasant stimuli.
- Low blood pressure may represent a vulnerability factor for developing depression.

ARTICLE INFO

Article history:
Received 15 October 2014
Received in revised form 24 February 2015
Accepted 25 February 2015
Available online 26 February 2015

Keywords:
Affect
Blood pressure
Emotional reactivity
Essential hypotension
Impedance cardiography
Transcranial Doppler sonography

ABSTRACT

Although low blood pressure has been associated with lower affect and higher depressive symptoms in the elderly, the presence of possible impairment in emotional reactivity in chronic hypotensive individuals in early adulthood remains largely unexplored. Using a combination of transcranial Doppler sonography, beat-to-beat blood pressure recording and impedance cardiography we assessed central and peripheral hemodynamic changes in 15 undergraduate women with chronic hypotension (Age: 23.9 ± 2.7 years) and 15 normotensive controls (Age: 23.7 ± 3.1 years) during sustained exposure to pleasant, unpleasant and neutral pictures. Overall, systolic blood pressure (SBP) increased in normotensives and decreased in hypotensives during picture viewing as compared to baseline. Also, compared to normotensives, in hypotensives mean cerebral blood flow velocity increased to a lesser extent during the viewing of pleasant pictures and the magnitude of this increase was negatively associated with subjective emotional arousal. In addition, in hypotensives screening SBP was positively associated with valence rating of pleasant contents. These findings indicate a close association between chronic low blood pressure and reduced processing of pleasant stimuli in young adulthood.

1. Introduction

In healthy adults, systolic blood pressure (SBP) should fall within the 120–140 mm Hg range [1,2]. However, some individuals chronically exhibit SBP values lower than this range, unrelated to the presence of any other pathological factors. This chronic condition of lowered blood pressure, called essential or chronic hypotension, is characterized by SBP below 100 mm Hg in women and below 110 mm Hg in men, and affects 0.3–4% of the general population. It is prevalent in women and is associated with impaired quality of life and lower mental and somatic well-being [3].

Physiological correlates of chronic hypotension include reduced body weight, creatinine and hemoglobin [4], cortical activation [5,6], cerebral perfusion [7–10], body temperature [4], as well as generalized day- and night-time cardiovascular down-regulation [11–14]. Moreover, several studies revealed that hypotensives suffer from cognitive difficulties, mainly in the attention and memory domains [5,6,10,15–17].

In addition to these physiological and cognitive alterations, individuals with essential hypotension often report anxiety, tiredness, and lack of motivation [3]. Also, several studies have shown a relationship between low BP and depression [18–21], with compelling evidence indicating that low BP is a predictor of depressive symptoms in the elderly [22,23]. Interestingly, Siennicki-Lantz and colleagues investigated the relationship between depressive symptoms, peripheral vascular disease, and cerebral blood flow, and found that a decline in cerebral

* Corresponding author at: Department of General Psychology, University of Padova, Via Venezia 8, 35131 Padova, Italy.
E-mail addresses: cellini.nicola@gmail.com, nicola.cellini@unipd.it (N. Cellini).

http://dx.doi.org/10.1016/j.physbeh.2015.02.047
0031-9384/

perfusion is associated with increased depression in non-demented, stroke-free octogenarian men [24]. It has also been suggested that low BP might be related to lower positive affect (a feature of depression), rather than to depression itself [25]. Taken together, these results suggest an association between low BP and negative mood in older people.

A core symptom of depression is dysfunctional emotional reactivity [26], characterized by decreased positive and increased negative emotionality as studied by means of psychological and physiological measures [27]. Depressive individuals often show lower positive affect and reduced emotional reactivity to both positive and negative events [28]. Moreover, impaired emotional processing seems to be a predictive factor of either the development and the course of depression [27,29].

Altogether, these observations suggest a possible association between blunted hemodynamic reactivity and poor positive and negative emotionality in hypotensive individuals, at least in older adults. This association may arise early on in life, becoming progressively chronic throughout adulthood and leading to the depressive symptoms observed later on in older hypotensives. Indeed, individuals with chronically low BP show lower cerebral blood flow velocities compared to normotensives already in early adulthood [7,8]. Notwithstanding this, the presence of possible impairment in emotional reactivity and mood in chronic young hypotensives remains largely unexplored. Stegagno and collaborators investigated the presence of possible impairment in emotional reactivity in young adults with hypotension [9]. In that work, a set of pleasant, unpleasant and neutral pictures was presented to a group of hypotensive and normotensive young women. Hemodynamic responses during picture viewing and subjective ratings of valence and arousal after each picture were measured. The authors found a dissociation between changes in perfusion and arousal ratings, as indicated by a smaller increase in cerebral blood flow velocity and higher subjective arousal for both positive and negative stimuli in hypotensives as compared to normotensives. These results suggest that reduced cerebral perfusion (rather than peripheral hemodynamic reactivity) may be a plausible causal mechanism for the blunted emotional reactivity observed in hypotensives. However, in this pioneering study no measures of mood were collected and the assessment of hemodynamic measures was limited to cerebral blood flow and BP. Also, no measure of sustained affective reactivity was provided, as emotional pictures were presented for 15 s each, followed by a 35 s pause. Importantly, physiological responses to emotional contents vary depending on the duration of the exposure [30]. Moreover, in real-world conditions, individuals are often exposed to long-lasting affective events [31], and a number of experimental studies have demonstrated that continuous presentation of positive (or negative) emotional stimuli can induce sustained affective states in laboratory settings [30,32]. Thus, sustained exposure to affective stimuli may be able to elicit and reveal blunted emotional responses in hypotensives.

In the current study we used a combination of continuous BP, cardiovascular measures derived from impedance cardiography, and transcranial Doppler sonography to assess both the peripheral and the cerebral hemodynamic pattern of emotional responses in young essential hypotensive women during sustained emotional visual stimulation. We hypothesized that sustained exposure to affective stimuli would lead to sustained reduced hemodynamic responses, which in turn would promote blunted emotional responses in hypotensives.

2. Materials and methods

2.1. Participants

Fifteen undergraduate women with hypotension (Age, mean ± SD: 23.9 ± 2.7 years) and 15 normotensive controls (Age, mean ± SD: 23.7 ± 3.1 years) participated in the experiment. We selected only female individuals according to the heightened rate of hypotension in the young female population [4,33]. All participants were drug free, non-smokers and did not report a history of medical/psychiatric problems. Participants were informed about the purpose of the study, and they gave written informed consent. The study protocol was approved by the local Ethic Committee and conformed with the principles outlined in the Declaration of Helsinki.

2.1.1. Procedure

In a screening session conducted at least one week prior to the experimental session, three blood pressure (BP) recordings were sphygmomanometrically taken in a seated position, separated by 5 minute rest intervals and after 10 min of resting. Participants with mean SBP <100 mm Hg were assigned to the hypotensive group, whereas individuals with mean SBP between 110 and 130 mm Hg were assigned to the normotensive group. Subjects were instructed to refrain from consumption of alcohol and caffeine for 3 h prior to the screening and experimental session. At the beginning of the experimental session this procedure was repeated to confirm the screening results. Afterwards, electrodes were applied to the participants and then they completed the trait version of the Positive and Negative Affect Schedule (PANAS; [59]) and the Beck Depression Inventory-II (BDI-II; [60]) to assess their affective profiles. After that, participants performed the picture viewing task in a dim-light and sound-attenuated room. The task lasted approximately 25 min. Subjects were continuously monitored by a closed-circuit video system for the entire duration of the task. At the end of the task, recording sensors were removed and participants were debriefed. Participants received € 13 as compensation for their participation.

2.2. Emotional stimuli

Ninety digitized pictures were selected based on their normative arousal and valence ratings from the International Affective Picture System (IAPS) [34] and organized in three blocks: 30 pleasant stimuli (erotic scenes and images of extreme sports; mean normative ratings: arousal 6.60, valence 6.75), 30 unpleasant stimuli (aimed guns, injuries and mutilations; mean normative ratings: arousal 6.63, valence 2.14), and 30 neutral stimuli (household objects, neutral faces and urban landscapes; mean normative ratings: arousal 3.07, valence 4.90).

Within each block, pictures of the same hedonic valence were continuously presented in a random order for 6 s each without an interstimulus interval. Each block lasted 3 min and was preceded and followed by 1 min of baseline and recovery, respectively (gray screens). Blocks were separated by 5 min inter-block intervals and the sequence of presentation was counterbalanced using a Latin-square design. At the end of each block, participants rated their subjective valence (i.e., state of pleasantness evoked by picture viewing) and arousal (i.e., state of activation evoked by picture viewing) of the whole block using a computerized version of the Self-Assessment Manikin (SAM) [34] on two 9-point graphic scales (from 1 to 9) presented at the end of each block.

2.3. Physiological recordings

Beat-to-beat SBP (mm Hg) and diastolic BP (DBP; mm Hg) were continuously recorded during baseline and task conditions by means of a photoplethysmographic cuff placed on the individual's middle finger of their non-dominant hand (Finapres® 2300, Ohmeda, Englewood, CO). The position of both hands was kept at heart level and maintained continuously throughout the experimental session.

Electrocardiogram (ECG) was recorded using Ag/AgCl surface electrodes placed in a modified Lead II Einthoven configuration through a Grass Model 7E Polygraph (Grass Instrument Co., W. Quincy, MA).

Impedance signals (Z_0) and the derivative of the impedance signals (dZ/dt) were acquired at 500 Hz sampling rate by ICG Minnesota Model 304 B (IFM Ins., Greenwich, CT, USA) using four aluminum bands placed in tetrapolar configuration with a constant current of 4 mA, 100 KHz. Signals were processed by the COP-WIN software system (BIT Inc., Chapel Hill, NC), which uses an ensemble averaging procedure to generate 30-s epochs after filtering out movement and