Cardiovascular-Emotional Dampening: The Relationship Between Blood Pressure and Recognition of Emotion

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Objective: Persons with elevated blood pressure (BP) show dampened emotional responses to affect-laden stimuli. We sought to further examine cardiovascular-emotional dampening by examination of the relationship between resting hemodynamic measures and recognition of emotion in an African American community-based sample. **Methods:** Participants were 106 African American men and women (55 women; mean age = 52.8 years), mainly low in socioeconomic status, and part of the Healthy Aging in Nationally Diverse Longitudinal Samples pilot study. Participants evaluated emotional expressions in faces and sentences using the Perception of Affect Test (PAT). Resting BP, total peripheral resistance (TPR), cardiac output, and heart rate were obtained continuously using a Portapres BP monitor. **Results:** Total PAT scores were inversely related to systolic ($r = -0.30$) and diastolic ($r = -0.24$) BPs, TPR ($r = -0.36$), and age ($r = -0.31$; p values $< .01$) and were positively related to cardiac output ($r = 0.27$) and education ($r = 0.38$; p values $< .01$), as well as with mental state ($r = 0.25$) and body mass index ($r = -0.20$; p values $< .05$). Accuracy of emotion recognition on the PAT tasks remained inversely related to TPR and BP after adjustment for demographic variables, medication, mental state, and body mass index. **Conclusions:** Elevated BP and TPR were associated with reduced perception of affect. TPR was the most consistent independent hemodynamic correlate of emotional dampening for the PAT scores. These results suggest potentially important links among central nervous system regulation of emotions, hemodynamic processes, and hypertension development. **Key words:** emotion regulation, blood pressure, hemodynamics, hypertension development, central nervous system, stress.

BP = blood pressure; **CNS** = central nervous system; **PAT** = Perception of Affect Test; **HANDLS** = Healthy Aging in Nationally Diverse Longitudinal Samples; **SES** = socioeconomic status; **CV** = cardiovascular; **HR** = heart rate; **TPR** = total peripheral resistance; **CO** = cardiac output; **SBP** = systolic blood pressure; **DBP** = diastolic blood pressure; **MMSE** = Mini-Mental State Examination.

INTRODUCTION

The relationship between blood pressure (BP) control and central nervous system (CNS) function in the development of essential hypertension is complex and multidirectional. For example, significant sustained elevations in BP can produce neuropsychological deficits in persons with established hypertension (1). Recently, however, a growing body of evidence suggests that subtle changes in CNS function can accompany or possibly precede BP increases, even within the normotensive range (2–5). The nature of these changes in brain function and their possible role in developmental pathophysiology of essential hypertension remains to be fully characterized.

The well-established relationship between BP and pain sensitivity suggests a heretofore-unappreciated mechanism of intimacy between brain function and BP control mechanisms. Reduced responsivity to painful stimuli has been well documented in hypertensive animals and humans (for a review, see Ghione (3)). This inverse relationship between BP and pain sensitivity has been shown to extend throughout the normotensive range (2,6,7). Interestingly, this hypoalgesia has been observed in persons with a family history of hypertension before significant BP elevations have occurred (8,9), suggesting that the CNS changes may parallel or even precede significant BP dysregulation. These findings suggest a previously uncharacterized interrelationship between cognitive appraisal of aversive stimuli and BP control.

Recent research suggests that BP-associated hypoalgesia may reflect a more generalized dampening of emotional responsivity. For example, several studies have shown significant relationships between BP and affective responses to pain (7,10,11). Moreover, this association between BP and affect dampening has been seen in emotionally laden contexts unrelated to acute or chronic pain. For example, Nyklícek and colleagues (12,13) found reduced subjective self-report of stress in some hypertensive patients. Moreover, they noted positive correlations between pain sensitivity and negative appraisal of psychological stressors, further suggesting that BP-associated hypoalgesia may reflect a more general effect on emotional responding.

These collective findings indicate that higher BP, even within the normotensive range, is associated with dampened response to emotionally laden aversive stimuli. However, those studies did not systematically address a potential relationship between BP and positive affectivity. Therefore, we designed a study to assess BP and responses to emotionally positive and negative photographic scenes from the International Affective Picture System in normotensive young adults (14). An emotional dampening hypothesis would postulate reduced affective response to both negatively and positively valenced stimuli. An alternative positivity bias hypothesis would postulate that persons with higher BP would show less negative appraisal of negatively valenced photographs and more positive appraisal of positively

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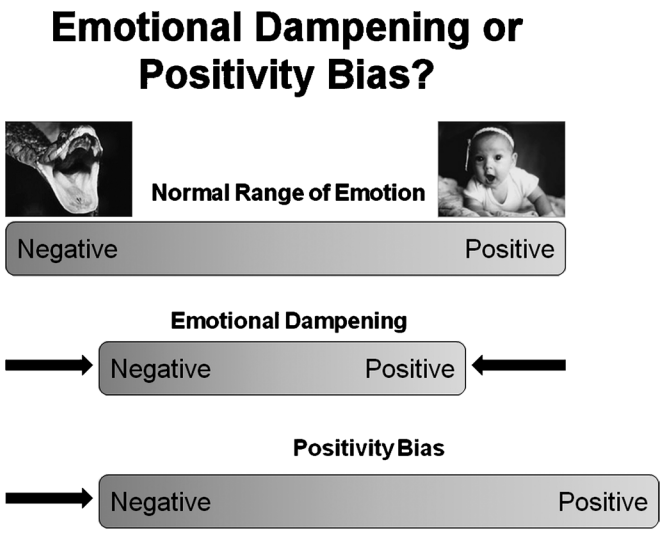

Figure 1. A comparison of the emotional dampening and positivity bias hypotheses. Cardiovascular-emotional dampening indicates that persons with higher blood pressure show reduced emotional response to stimuli with negative emotional valence and stimuli with positive emotional valence. Positivity bias indicates an overall positive shift, where persons with higher blood pressure show reduced emotional response to stimuli with negative emotional valence and increased emotional response to stimuli with positive emotional valence.

valenced photographs (Fig. 1). Results showed that higher BP was associated with decreased intensity of emotional response to both positive and negative affective contents, providing initial support for the cardiovascular (CV)-emotional dampening hypothesis.

Coupled with the pain sensitivity data, these findings suggest that persons with elevated BP or other hypertension risk factors may also have impaired recognition of emotional meaning in, for example, facial expressions, written communication, and possibly other important modalities of emotion expression. If this is the case, then persons at risk for hypertension may show significant impairment in recognition and response to emotionally relevant communication by others. This emotional dampening may produce potentially adverse affects on social relationships, with increased psychosocial distress and possibly additional BP dysregulation.

The present study seeks to further examine emotional dampening by examination of a) its effects on recognition of emotion in faces and written narratives, b) its generalizability to an older high-risk population, and c) its underlying hemodynamic correlates. We used the Perception of Affect Test (PAT) (15) to determine whether elevated resting CV levels were related to reduced recognition of emotionally salient stimuli in an African American community-based sample (Healthy Aging in Nationally Diverse Longitudinal Samples [HANDLS] pilot study). We hypothesize that higher BP will be related to decreased accuracy in recognition of emotion in verbal (sentences) and nonverbal (faces) contents. In addition, we examined the role of total peripheral resistance (TPR) and cardiac output (CO) in the relationship between BP control and emotional dampening. Finally, the influence of resting CV levels on perception of affect was examined in a sample of African American adults mostly of low socioeconomic status (SES) with an average age of 52.6 years.

METHODS

Participants were part of the HANDLS pilot study. Demographic characteristics for the HANDLS pilot sample are shown in Table 1 ($N = 106$; women, 52%; mean [standard deviation] age = 52.6 [14.6] years). Most participants were of low SES based on national norms and living in neighborhoods with

TABLE 1. Means, SDs, and Ranges of Demographic Variables, Average CV Levels, and PAT Accuracy Scores

	Total			Women			Men		
Variable	M	SD	Range	M	SD	Range	M	SD	Range
Age, y	52.6	14.6	21–92	55.1	15.6	21–92	49.8	13.1	26–83
Education	11.9	3.3	3–18	11.3	3.3	3–17	12.5	3.2	3–18
MMSE	26.4	3.0	15–30	26.4	2.4	20–30	26.4	3.5	15–30
BMI	27.7	7.6	16–52	29.9	7.8	16–52	25.2*	6.6	16–49
Average CV levels									
SBP	143.9	27.4	101–254	147.4	28.7	104–230	140.1	25.7	101–254
DBP	84.4	12.0	63–124	82.0	10.1	63–103	87.1*	13.3	63–124
TPR	1.5	0.8	0.7–5.8	1.4	0.6	0.7–3.1	1.7*	1.0	0.7–5.8
CO	5.1	1.7	1.9–10.8	5.4	1.8	2.2–10.8	4.8	1.6	1.9–8.8
HR	76.0	12.7	47–107	76.9	12.2	46–107	75.0	13.2	49–104
PAT scores									
Total	74.3	13.5	37–99	74.1	13.0	37–99	74.4	14.3	43–93
Faces	74.3	13.7	40–100	74.3	13.5	40–100	74.4	14.0	41–91
Sentences	74.2	16.6	23–100	74.0	16.0	23–97	74.4	17.3	34–100
Negative	70.3	14.9	30–100	70.6	15.4	30–100	70.0	14.5	38–93
Positive	81.6	15.0	35–100	80.8	13.5	40–100	82.5	16.5	35–100

SD = standard deviation; CV = cardiovascular; M = mean; MMSE = Mini-Mental State Examination; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; TPR = total peripheral resistance; CO = cardiac output; HR = heart rate; PAT = Perception of Affect Test.
* $p < .05$ for sex difference.

high rates of polydrug substance use, violent crime, and sexually transmitted diseases. The data were collected in a custom-built mobile laboratory or a community room in an apartment building, which were located in an urban, predominantly African American Baltimore neighborhood. Although all participants reported at least some African American background, the only inclusion criterion was age 18 years or older. Participants received $40 on completion of the HANDLS pilot study.

Protocol

Written informed consent was received before the experimental session. The participant sat in a chair directly across from the experimenter, whereas the experimenter provided an overview of the study. The experimenter recorded the participant's age and sex. The experimenter then connected the participant to a recording device that collected beat-to-beat readings of BP and heart rate (HR), whereas the participant sat and rested for 5 minutes. The participant then completed the sentences and faces subtasks of the PAT. An additional 5-minute rest period ensued after task completion. Approximate dates of data collection were from September 2000 to September 2002. All procedures were approved by the Medstar/Harbor Hospital institutional review board.

Sentences Subtask

The experimenter gave the participant blank forms for the sentences subtask and instructions on how to complete items. The experimenter asked the participant to read (or listen to the experimenter reading aloud) 35 sentences and match the perceived emotional response of the underlined character in each sentence to one of the following response options: happy, sad, fear, anger, disgust, surprise, and neutral emotion. Five sets of sentences represented each of the seven emotions. For example, one anger item from the PAT-sentences is "Being sure that his players did nothing wrong, a coach demands an explanation from the referee about the penalty call."

Faces Subtask

Next, the experimenter showed the participant 35 photographs of faces with varying expressions and asked the participant to indicate which emotion (of the seven options previously mentioned) was the best match for the expression in the face. Five sets of faces stimuli represented each of the seven emotions.

The sentences and faces subtasks were counterbalanced and have been normed in previous research with community-based aging populations (16). This task has proven to be reliable and sensitive to multiple measures of emotion awareness, anxiety, defensiveness, and coping style (15,16). After the protocol, the experimenter debriefed the participant.

CV Assessment

A Portapres beat-to-beat BP monitor (Finapres Medical Systems B.V., Amsterdam, The Netherlands) was used to collect CV measures. The Portapres (17) is an ambulatory monitor that uses the arterial clamp method (Penaz method) to collect continuous BP and HR waveforms that are analyzed offline using a Modelflow (18) technique and BeatScope 1.1 software (19) to produce reliable estimates of stroke volume, TPR, and CO. This software uses the Wesseling algorithm, which computes aortic flow waveform from the arterial pressure signal. The aortic diameter can be different based on age and sex parameters. Thus, the Modelflow technique uses age and sex group norms to estimate diameter and stroke volume. In turn, measures of HR and stroke volume allow for computation of CO (in liters per minute) and TPR (in millimeters mercury seconds per milliliter). In humans, this technique compares well with CO and stroke volume as measured by radial artery catheterization and CO as determined by Doppler ultrasound (20,21). For example, the overall CO root-mean-squared normalized error was 15.3% with respect to the direct arterial measures and 15.1% with respect to Doppler ultrasound measures.

The experimenter placed a finger BP cuff on the middle phalanx of the two fingers of the nondominant hand and then attached a height correction transducer from the front-end unit of the Portapres to the upper arm of the participant's nondominant arm at heart level. Average CV parameters were calculated across all values obtained at rest.

Analysis of PAT

Various scores representing the correct identification of emotional stimuli (higher scores mean better recognition) were computed as follows. Total PAT score was calculated as the proportion of correct responses to total responses (across faces and sentences). Total faces score was calculated as the percentage of correct responses for the faces task. Total sentences score was calculated as the percentage of correct responses for the sentences task. Proportion scores for each task were calculated if participants had more than 29 responses. Nine participants had four or more missing values and were excluded from analyses. Individual emotion scores were calculated as the proportion of correct responses to total responses across and within tasks (for each emotion). Scores for each emotion were prorated if participants had fewer than five, and participant data were not used if fewer than three responses were obtained. No participants had more than one missing value for any emotion-task category. Cronbach α's for each subtask and for the total PAT score were as follows: faces, 0.72 (n = 99); sentences, 0.78 (n = 93); and total, 0.83 (n = 87).

Prior research suggests that the valence of emotional stimuli (positive or negative) may provide valuable information about emotion recognition (22,23). Therefore, proportion scores were computed for negative and positive stimuli across faces and sentences tasks.

Measures of Education and Cognitive Function

Educational attainment was measured as the total number of years of formal education. Thus, scores could range from 1 to 20 years. The mean educational attainment (Table 1) was consistent with the demographic characteristics of the surrounding neighborhood. Men had marginally higher educational attainment than women did ($t = -1.79$, $df = 104$, $p = .07$).

Total scores on the Mini-Mental State Examination (MMSE) (24) were analyzed to determine whether cognitive capacity confounds PAT performance, especially the sentences. Because the sample is primarily low on educational attainment, it could be argued that poor PAT performance could, in large part, be a function of poor cognitive skills associated with inadequate educational attainment. The MMSE has been used as an indicator of cognitive aging in African American and white aging populations (25). In the present study, there was no sex difference in mean MMSE score (Table 1).

Measures of Health Risk: Hypertension and Body Mass Index

Prevalence of hypertension and diabetes are highly correlated, and at least some of their pathophysiologies and treatments are known to affect CNS function (26–28), so a dummy variable (yes or no) was created to assess hypertension/diabetes medication usage (including angiotensin-converting enzyme inhibitors, β-blockers, calcium channel blockers, diuretics, hypoglycemics, or other related medications). In the current sample, 44 persons (42%) were coded as positive for medication usage.

Numerous epidemiologic studies have found body mass index (BMI) to be a risk factor for poor CV health outcomes (28). We obtained measures of height and weight in inches and pounds, respectively, from each subject and then converted these values into meters and kilograms, respectively, to compute BMI scores (BMI = kg/m^2). The mean BMI score for the total sample and by sex is shown in Table 1. Women had significantly higher mean BMI score than men did.

Plan for Statistical Analysis

Mean scores for TPR, CO, systolic BP (SBP) and diastolic BP (DBP), and HR were computed for the rest periods. Analyses were performed with SPSS-PC software (IBM, Armonk, NY), and an α level of 0.05 was adopted for all statistical tests. Statistical analyses included correlational tests for demographic variables, MMSE, resting CV levels, and the various PAT scores. We conducted a series of hierarchical multiple regression tests with independent variables entered in the following steps: a) sex, age, education, and BMI; b) medication usage; c) MMSE score; and d) the specific average resting CV levels, individually, with the selected PAT score as the dependent measure for each test. Thus, we tested the role of resting CV levels on perception of affect after

TABLE 2. Zero-Order Correlations (Two-Tailed) for Average Cardiovascular Levels, Demographic Variables, and MMSE With PAT Accuracy Scores

PAT	Systolic BP	Diastolic BP	TPR	Cardiac Output	Heart Rate	Age	Education	MMSE	BMI
Total	−0.30**	−0.24**	−0.36**	0.27**	0.15	−0.31**	0.38**	0.25*	0.20*
Faces	−0.31**	−0.19*	−0.33**	0.25**	0.18	−0.38**	0.27**	0.15	0.18
Sentences	−0.23**	−0.22*	−0.31**	0.23**	0.10	−0.19	0.39**	0.28**	0.17
Negative	−0.24**	−0.20*	−0.35**	0.29**	0.13	−0.22*	0.32**	0.27**	0.27**
Positive	−0.33**	−0.24**	−0.29**	0.18	0.16	−0.38**	0.32**	0.15	0.07

MMSE = Mini-Mental State Examination; PAT = Perception of Affect Test; BP = blood pressure; TPR = total peripheral resistance; BMI = body mass index.
* $p < .05$, ** $p < .01$.

adjustment first for relevant sociodemographic factors, then for medication status, and then for cognitive functioning.

RESULTS

Table 1 shows descriptive statistics for PAT-total, PAT-sentences, and PAT-faces, PAT-negative, and PAT-positive scores. The results indicate that participants in the current study have lower PAT scores than the predominately white sample in the study of Lane et al. (15). However, the minimum PAT scores are higher for participants in the HANDLS pilot study. Although there were no significant sex differences for any PAT score, supplemental analyses suggest that older men had the most trouble correctly identifying emotional expressions, especially negative emotions.

Zero-order correlations showed that PAT scores were inversely related to SBP and DBP, TPR, and age and positively related to CO, education, mental state, and BMI (Table 2). In particular, higher SBP, DBP, and TPR were significantly correlated with lower scores on PAT-total, PAT-faces, PAT-positive, and PAT-negative. Lower CO was linked with lower PAT scores. HR was not significantly correlated with PAT scores.

Zero-order correlations for demographics and MMSE with PAT accuracy scores (Table 2) showed that increasing age was associated with lower PAT-total and for PAT-faces, PAT-positive, and PAT-negative subtest scores. Higher education levels were significantly associated with higher PAT-total and all subtests. Lower MMSE scores were correlated with lower PAT-total, PAT-sentences, and PAT-negative scores. BMI was positively correlated with PAT-total and PAT-negative scores.

PAT-Total

Table 3 shows the results for the hierarchical multiple regression models for each CV variable (Steps 4a–4e) and PAT-total score. Higher TPR was significantly related to lower PAT-total scores ($p = .033$), with nonsignificant trends for DBP ($p = .065$) and SBP ($p = .094$). Higher education and BMI, and lower age were significantly related to higher PAT-total scores. There was a nonsignificant ($p = .055$) trend for higher MMSE scores to be associated with higher PAT-total scores. Figure 2 shows the average (±standard error) PAT-total scores for the high- and low-TPR groups based on a TPR median split. Differences between groups were significant ($t = 3.155$, $df = 104$, $p = .002$).

PAT-Negative

Regression results for PAT-negative are shown in Table 4. Higher TPR was significantly associated with lower PAT-negative ($p = .029$). Higher educational attainment, BMI, and MMSE scores were significantly related to higher PAT-negative performance. There was a nonsignificant ($p = .061$) trend for older age to be associated with lower performance on the PAT-negative subtest.

TABLE 3. Regression of Demographics, Medication Usage (Rx), MMSE Score, and Average Cardiovascular Levels on PAT-Total Score

	R^2	R^2 Change	Significant *F* Change	β	*t* (β)	*p*
Step 1:						
Sex	0.215	0.215	0.000	−0.020	−0.203	.839
Age				−0.269	−2.720	.008
Education				0.255	2.580	.011
BMI				0.222	2.268	.026
Step 2: Rx	0.216	0.001	0.711	0.041	0.371	.711
Step 3: MMSE	0.248	0.032	0.055	0.181	1.944	.055
Step 4a: systolic BP	0.271	0.023	0.094	−0.181	−1.693	.094
Step 4b: diastolic BP	0.276	0.028	0.065	−0.175	−1.871	.065
Step 4c: TPR	0.286	0.038	0.033	−0.234	−2.170	.033
Step 4d: CO	0.255	0.007	0.376	0.112	0.890	.376
Step 4e: HR	0.259	0.011	0.252	0.114	1.152	.252

Rx = prescription; MMSE = Mini-Mental State Examination; PAT = Perception of Affect Test; BMI = body mass index; BP = blood pressure; TPR = total peripheral resistance; CO = cardiac output; HR= heart rate.

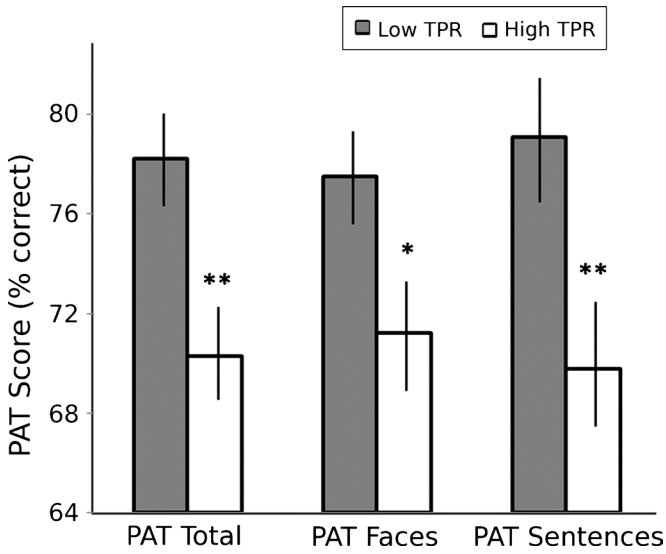

Figure 2. Average percent correct (±standard error). Perception of Affect Test (PAT) scores in persons with low versus high resting total peripheral resistance (TPR). * $p < .025$, ** $p < .005$ in high- versus low-TPR groups.

PAT-Positive

Regression results for PAT-positive are shown in Table 5. Higher SBP ($p = .025$) and DBP ($p = .033$) were significantly associated with lower PAT-positive scores. Older age was significantly related to lower performance on the PAT-positive subtest. There was a nonsignificant ($p = .087$) trend for higher educational attainment to be associated with higher PAT-positive scores.

PAT-Sentences

The hierarchical multiple regression models for PAT-sentences showed higher TPR was significantly ($p = .032$) related to lower PAT-sentences scores with a nonsignificant trend for DBP ($p = .095$). Both higher educational attainment and MMSE score were significantly associated with higher PAT-sentences performance. There was a nonsignificant ($p = .097$) trend for higher BMI to be associated with higher PAT-sentences scores. Figure 2 shows the average (±standard error) PAT-sentences scores for high and low TPR groups based on a TPR median split. Differences between groups were significant ($t = 2.995$, $df = 104$, $p = .003$).

PAT-Faces

The hierarchical multiple regression models for PAT-faces indicate that PAT-faces scores were not significantly associated with any of the CV variables, although both younger age and higher BMI were associated with higher PAT-faces performance. Figure 2 shows the average (±standard error) PAT-faces scores for the high- and low-TPR groups based on a TPR median split. Differences between groups were significant ($t = 2.437$, $df = 104$, $p = .017$).

DISCUSSION

The present results show a significant relationship between resting CV function and recognition of affective content in photographs of faces and written narratives. Persons with high resting BP and TPR show significantly reduced responses to both positively and negatively valenced faces and sentences. Although recognition accuracy in the current population is also related to age, education, and mental status, the relationship between CV function and emotional dampening seems independent of medication, mental status, education, BMI, age, and sex. This reduced ability to detect and/or respond to emotional cues is consistent with the relationships between BP levels and responses to pain (6,7), affective images (14), and self-reported stress (13). Paradoxically, dampened subjective reports of emotion in persons with elevated BP may be accompanied by increased autonomic and circulatory reactivity to stress (29). Thus, there seems to be a complex intimacy between emotional dampening and CV dysregulation. This psychophysiological link between CV control and

TABLE 4. Regression of Demographics, Medication Usage (Rx), MMSE Score, and Average Cardiovascular Levels on PAT-Negative Score

	R^2	R^2 Change	Significant *F* Change	β	*t* (β)	*p*
Step 1:						
Sex	0.186	0.186	0.001	−0.001	−0.006	.995
Age				−0.191	−1.896	.061
Education				0.227	2.257	.026
BMI				0.289	2.900	.005
Step 2: Rx	0.187	0.001	0.775	0.032	0.287	.775
Step 3: MMSE	0.230	0.043	0.027	0.213	2.251	.027
Step 4a: systolic BP	0.244	0.013	0.215	−0.136	−1.248	.215
Step 4b: diastolic BP	0.249	0.019	0.137	−0.143	−1.500	.137
Step 4c: TPR	0.271	0.041	0.029	−0.242	−2.229	.029
Step 4d: CO	0.243	0.013	0.218	0.157	1.242	.218
Step 4e: HR	0.240	0.009	0.302	0.104	1.037	.302

Rx = prescription; MMSE = Mini-Mental State Examination; PAT = Perception of Affect Test; BMI = body mass index; BP = blood pressure; TPR = total peripheral resistance; CO = cardiac output; HR= heart rate.

TABLE 5. Regression of Demographics, Medication Usage (Rx), MMSE Score, and Average Cardiovascular Levels on PAT-Positive Score

	R^2	R^2 Change	Significant *F* Change	β	*t* (β)	*p*
Step 1:						
Sex	0.188	0.188	0.001	−0.024	−0.240	.811
Age				−0.346	−3.436	.001
Education				0.174	1.731	.087
BMI				0.110	1.107	.271
Step 2: Rx	0.189	0.001	0.709	0.042	0.374	.709
Step 3: MMSE	0.196	0.007	0.377	0.086	0.887	.377
Step 4a: systolic BP	0.241	0.044	0.025	−0.249	−2.284	.025
Step 4b: diastolic BP	0.237	0.040	0.033	−0.209	−2.172	.033
Step 4c: TPR	0.212	0.016	0.179	−0.153	−1.354	.179
Step 4d: CO	0.196	0.000	0.954	0.007	0.057	.954
Step 4e: HR	0.208	0.011	0.260	0.116	1.134	.260

Rx = prescription; MMSE = Mini-Mental State Examination; PAT = Perception of Affect Test; BMI = body mass index; BP = blood pressure; TPR = total peripheral resistance; CO = cardiac output; HR= heart rate.

regulation of emotion remains to be fully understood. Moreover, the potential clinical significance of CV-emotional dampening in the etiology of essential hypertension urges further investigation.

CV-Emotional Dampening and Stress

The precise causal pathways between CV function and emotional dampening have not yet been fully clarified but are likely complex and multidirectional. For example, emotional dampening could directly result from circulatory function via visceral afferent processes or, in advanced clinical hypertension, CNS microcirculatory pathology. Alternatively, emotional dampening could be a marker for CNS changes that contribute directly to BP elevation. In addition, the phenomenon of CV-emotional dampening could reveal parallel and perhaps progressive changes in both CNS function and autonomic control of circulation. Separately or in combination with the previously mentioned, emotional dampening could also increase psychological stress, thus further increasing BP. For example, emotional dampening could increase psychosocial distress through emotionally inappropriate interactions with others, including family, friends, coworkers, and supervisors. Thus, emotional dampening could contribute directly to chronic stress levels, further exacerbating potentially pathogenic CV responses.

Reduced recognition of emotional content could be associated with increased psychosocial distress in several ways. For example, effective stress management relies on sensitive and accurate recognition of emotional, threatening, and/or stressful situations to appraise and respond appropriately in complex environments. Social relations including social support networks are bolstered by empathy, emotional bonding, and trust. Impaired recognition of emotions in verbal and nonverbal communication could be associated with reduced quality of social relationships, social isolation, and emotional distancing from family, friends, and work associates. Therefore, impaired recognition of emotional cues is likely more than a simple marker of the parallelism between CV and CNS functions. It is also a mechanism that could increase psychosocial distress, producing additional neuroendocrine and autonomic disturbance of CV function. Moreover, the dampening of emotionally positive experiences may interfere with the restorative functions of leisure, hobbies, and positive social relationships. Thus, the potential threats of emotional dampening to normal psychological, social, and physiological functioning merit extensive future study to enumerate the correlates, causes, consequences, and possible therapeutic interventions.

Regulation of Emotion and BP

The present study supports and extends the emotional dampening hypothesis in several significant ways. First, this study extends the relationship between CV function and assessment of emotionally laden stimuli to older African Americans predominantly of low SES at elevated risk for CV disease. Second, CV-emotional dampening has been linked to reduced accuracy in recognition of emotional expression in narrative texts and faces. Third, after adjustment for potentially confounding variables, emotional dampening remains associated with increased BP and TPR.

Emotional dampening in a population of older African American men and women at elevated risk for CV disease is important for several reasons. Hypoalgesia has been observed in hypertensive humans and animals (3). The relationship between BP and pain sensitivity is well documented throughout the normotensive range and has been observed in persons with a family history of hypertension (7,8), including newborn infants (30,31). To our knowledge, this is the first evidence of emotional dampening in older African Americans mostly of lower SES. Resting CV parameters were significantly related to PAT score after correction for demographics (i.e., age, education, sex), medications, and mental status. CV-emotional dampening seems conceptually similar to alexithymia (15,16), but emerging evidence suggests that it is an independent phenomenon. For example, a recent preliminary study of healthy young adults from our laboratory shows that BP significantly related to PAT

scores ($p = .001$) after adjustment for both age and alexithymia (32). This suggests that the CV-emotional dampening observed in the HANDLS sample may be independent of alexithymia. The present findings point to a basic CNS mechanism linking regulation of emotion and CV function, independent of age, education, sex, medications, and mental status.

Neurocirculatory Implications

The precise mechanisms linking BP and/or hypertension risk and emotional dampening are not yet fully clarified. Although there is significant evidence linking both sinoaortic and cardiopulmonary baroreflex mechanisms to pain sensitivity (33–35), a recent study suggested that emotional dampening may not be mediated via baroreflexes in persons with parental hypertension (36). A series of studies has implicated endogenous opioid peptides in BP-associated hypoalgesia; the body of evidence suggests involvement of both opioid and nonopioid mechanisms (6,7). Whereas most of the original studies on pain sensitivity emphasized the relationship with either BP or familial risk for hypertension, the present study is one of the first to examine indices of TPR. PAT scores were most consistently related to TPR after correction for demographics, medications, and mental status, suggesting that the primary independent CV phenomenon may reflect vascular processes, at least in the current population. These processes could include both active vasoconstriction but may also reflect vascular compliance and other structural changes as well. Prior studies have found that dampening is strongly tied to chronic resting BP levels. This suggests that the common CNS and circulatory mechanisms may be embodied in the regulation of the set point of BP that determines the chronic level of BP rather than acute BP changes around that set point. Although certain antihypertensive medications have been shown to normalize pain sensitivity in hypertensives, these effects are not necessarily linked directly with BP lowering (37). This supports the notion that the common mechanism may be most closely linked to the chronic baroreflex set point rather than acute baroreceptor sensitivity. Regardless of the precise mechanism, the intimate relationship between emotional dampening and BP control mechanisms may help better characterize the role of the CNS in autonomic and circulatory function during the early stages of development of essential hypertension.

HANDLS Sample Characteristics

The present study was designed to focus on a neighborhood sample that was primarily older African American and with lower SES. Therefore, our sample has characteristics that reflect that mission. For example, women in this sample have a significantly higher BMI than men (Table 1). Moreover, the wide range of MMSE scores in this sample suggests caution in the interpretation of results. Our diverse HANDLS sample included individuals up to 92 years of age and with educational attainment as low as 3 years. This is a demographic range where normative MMSE screening guidelines are not well established. However, in a subsidiary analysis, exclusion of total MMSE scores lower than 24 did not substantially alter our findings. In light of these results and adjustment for MMSE scores in the full sample models, the overall findings are not likely distorted by persons with possible dementia. Most importantly, our emotional dampening findings are supported despite the wide range of age, education, BMI, and MMSE scores in the current HANDLS sample.

CONCLUSIONS

Emotional dampening is related to levels of resting BP, TPR, and other indices of hemodynamic function in a sample of middle-aged African Americans predominantly of lower SES who are at a significantly elevated risk for CV disease. The present findings provide support for a CV-emotional dampening hypothesis and are consistent with the neurovisceral integration model (38). The role of emotional dampening in the developmental etiology of hypertension requires further study, but the present results suggest potentially important links among CNS regulation of emotions, neural control of circulation, and hypertension development.

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