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Relations of Subjective Social Status and Brooding with Blood Pressure

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Abstract

Background Brooding, a type of rumination, and subjective social status (SSS) may be two interacting factors for cardiovascular disease (CVD). Our goal was to examine the relations of brooding and SSS with systolic blood pressure (SBP) and diastolic blood pressure (DBP), two measures of CVD. We predicted that [1] brooding and SSS are each related to SBP and DBP and [2] the interaction of brooding and SSS is linked to SBP and DBP.

Method In this cross-sectional study, college student participants ($n = 240$; 58.6% female, age: $M = 23.95$ years, $SD = 8.62$) completed demographics questionnaires, the Ruminative Response Scale, and MacArthur Subjective Social Status scale, and gave blood pressure samples.

Results Linear models suggested that, for participants low in SSS, high brooding and DBP were positively related. For participants high in SSS, high brooding and low DBP were negatively related. There were no relations between SSS, brooding, and SBP.

Conclusions As predicted, for individuals with low SSS, more brooding was associated with higher DBP. Yet, in individuals with high SSS, more brooding was associated with lower DBP. There was no relation between SSS, brooding, and SBP. Our results suggest that brooding may serve as diathesis for some symptoms of CVD (i.e., high DBP but not high SBP) in individuals with low SSS. We discuss how other factors, like burnout or defensive pessimism, may contribute to the relation between high SSS, high brooding, and low DBP.

Keywords Brooding · Rumination · Cardiovascular disease · Blood pressure

Acronyms

DBP	Diastolic blood pressure
SBP	Systolic blood pressure
SSS	Subjective social status
SES	Socioeconomic status
BMI	Body mass index
CVD	Cardiovascular disease

Introduction

CVD and related health conditions place considerable strain on the health and economy of Americans leading to annual losses of billions of dollars [1]. CVD is a leading cause of death [1, 2] and a chief contributing factor to physical impairment and disability in the USA [3]. Research has consistently shown that certain factors, like lifestyle decisions or body mass index (BMI), can predispose people to the development of CVD [4]. Yet, these factors account for less than 50% of the variance of CVD onset [5]. Although important targets for intervention, changing lifestyle decisions and reducing BMI may not be enough to reduce the impact of CVD in the USA.

With so much variance in CVD unexplained, prevention efforts have turned to examine other types of factors that may be contributing to disease onset. Research has suggested that cognitive factors are related to physical health, including CVD [6]. One cognitive factor related to physical health is trait rumination (hereafter referred to as rumination), a cognitive style marked by the tendency for an individual to turn their focus inward towards the symptoms or potential causes of their emotional distress [7, 8]. Rumination may chronically prolong negative emotional states beyond their initial length adding wear and tear to the body as it maintains activation, causing the body to enter allostasis across longer periods of time [9] and making

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the individual vulnerable to physical illness, like CVD [6], as the body decompensates. Similarly, a social-cognitive factor linked to CVD is SSS [10]. SSS is the way an individual assesses their social standing relative to their peers [11]. At the trait level, low SSS predicts a higher incidence of CVD [11, 12]. Both trait rumination and SSS have been linked to higher instance of CVD, but it is unclear if or how they interact to promote disease pathogenesis.

Application of a Diathesis-Stress Model

Many modern approaches to understanding CVD utilize diathesis-stress models. Diathesis-stress models emphasize that certain traits or characteristics an individual possesses (i.e., diatheses) combine with the psychological impact of stressors to produce disease [13, 14]. In the modern view of diathesis-stress, a "stressor" is defined as anything that taxes the allostatic load and makes the body rise to cope with a challenge [15]. This includes "real, simulated, or imagined challenges" [15], such as comparing oneself to others. Diathesis-stress models enable researchers to track the ways in which processes or factors alter the influences of others [16]. Put another way, these models allow for the examination of how specific diatheses moderate [17] or mediate [18] the relation between stressors and various diseases. For example, exposure to stress is associated with CVD [19], but exposure to stress alone does not fully explain pathogenesis of CVD because not everyone exposed to stress develops CVD. Given this, one way to better understand pathogenesis of CVD is to examine which factors are diatheses for its development.

Ruminative Response and Its Subtypes as Diathesis of Cardiovascular Health

Rumination has been proposed as a cognitive diathesis for mental [8] and physical health [20]. In the response style theory, it is proposed that this relation exists because rumination is a trait-like way that individuals dwell on negative emotions and thoughts relating to past events, thus rendering them susceptible to mood disturbance [21]. In terms of physical health, rumination has been associated with atypical levels of the stress hormone cortisol [22], which is theorized to be part of CVD pathogenesis [23]. Rumination may be one diathesis that interacts with stress to promote CVD pathogenesis.

Although two types of ruminative response have been found, brooding is typically the subtype connected to long-term poor health [24]. Brooding involves a non-adaptive, passive focus on negative events and does not aid in individuals' problem-solving, leaving them to dwell on current suffering [8, 21, 25, 26]. Brooding rumination specifically has been linked to increased cortisol [27], although this type of brooding was induced in laboratory rather than assessed as a trait. Individuals high in trait brooding are more likely to have exaggerated cardiovascular responses to stress than those low in trait brooding [28]. It thus follows that they may also be more likely to have elevated resting blood pressure as blood pressure is also a measure of cardiovascular reactivity [28]. However, there has been no study to date that has examined brooding as a vulnerability for elevated blood pressure. Thus, future research is warranted to further understand the potential impact of brooding on CVD.

Subjective Social Status as Stressor of Cardiovascular Health

Like rumination, low social status is linked to physical health. One measure of social status is SES, which has been shown to predict physical health [29, 30] in that those with higher SES tend to have more favorable health than those of low SES [30–32]. One explanation for the relation between SES and health may be that perceptions of one's social status may impact stress pathways [33]. SES is connected to one's health in numerous ways, one of which may be through perceptions of one's position in a social hierarchy.

SSS is the perception of how one compares to their peers [10], which relates to the perception of where one lies within the social hierarchy [34]. SSS also contains non-economic factors, such as relative prestige [32] or admiration from peers [35]. Socioeconomic position, as measured by SSS, is linked to physical health, and low SSS in particular has been connected to poorer health outcomes. Humans are motivated to protect their social status because those who are higher in social status may be more valued by the group and have access to more social capital [36]. Perceiving low SSS, because of its relation to an upward social comparison to peers, may represent a social-evaluative threat, a stressor in which one's social identity and access to social capital are challenged [36]. SSS may be connected to physical health because the lower one's SSS, the great their perceived social-evaluative stress.

SSS positively correlates with SES and is a better predictor of physical health than SES [10]. Low SSS has been linked to CVD [11], as well as a variety of traditional risk factors of CVD, including DBP and SBP [37]. However, research on SSS and physical health is not entirely consistent. For example, a study comparing survey results of European and American samples found a negative relation between SSS and hypertension (participants with SBP/DBP of 135/85 mmHg or greater) in all groups except Black males [11]. Similarly, another study [10] did not find a significant relation between SSS and SBP in all-female samples. A possible explanation for this inconsistency could be that SSS does not impact blood pressure independent of other variables and that it needs to be understood as stressor within a diathesis-stress model. In other words, only in interaction with diatheses (e.g., rumination) does it influence blood pressure.

The Current Study

The purpose of the current study was to apply a diathesis-stress model [38] from depression literature [7, 8, 39] to blood pressure research. This study focused on the relation between brooding, stress (i.e., low SSS), and SBP and DBP. Based on the described literature, we predicted that brooding and SSS [37] are each independently associated with SBP and DBP and that the interaction of lower SSS by more brooding and is related to elevated blood pressure SBP and DBP [27].

Methods

Participants

Data were collected from 243 community college students in a medium-sized metropolitan area in the southern USA. The sample was 58.6% female with ages ranging from 18 to 62 ($M = 23.95$, $SD = 8.62$). The racial breakdown of the sample included Asian or Asian-American (3.4%), Black (30.3%), Hispanic or Latino (9.6%), mixed race (3.7%), Native American (0.3%), and White (50.5%). Self-reported income ranged from below $10,000 to greater than $100,000 annually.

Measures

Demographics Self-reports of biological sex, weight, height, birthdate, prior and current use of cigarettes, current consumption of alcohol, SES, BMI, familial history of elevated blood pressure, cardiovascular disease, stroke, and ethnicity/race were collected.

Blood Pressure Research staff were trained in taking the blood pressure following standard measurement procedures using the Omron BP710N, which produces readings based on oscillometry [7]. During blood pressure measurement, participants sat with uncrossed legs and good posture, placing their forearm and elbow on the table with their palms upward. Blood pressure measurement was taken with the cuff approximately an inch above the upper arm crease. Blood pressure recordings were taken 1 min apart, three times each, with the scores averaged. This method of blood pressure measurement has been used in health psychology research previously [40, 41].

Rumination Response Subscale The Ruminative Response Subscale (RRS; [21]) is part of the Response Style Questionnaire. The RRS contains five items that assess the frequencies of participants' brooding [24]. Using a Likert-scale, participants endorse items ranging from 1 (*almost never*) to 4 (*almost always*), to select the frequency of various thoughts (e.g., "why do I have problems that other people don't have?"). Internal consistency reliability of the brooding subscale in the current sample was $\alpha = .81$.

The MacArthur Subjective Social Status Scale The MacArthur Scale of Subjective Social Status assesses individuals' perceived social status accounting for various dimensions of SES and social ranking like income, education, or occupational title [42]. The scale presents a picture representing a social ladder instructing participants to indicate on which rung they stand compared to their peers nationwide. At the top rung are those with the best financial, education, and social resources [42] as well as assumed prestige among peers [32]. At the bottom rung are the worst off financially [42] with the least prestige among peers [32]. The MacArthur Social Status Scale has been used in multiple studies [32, 43], and information regarding its validity and reliability is available in detail elsewhere [42].

Procedures

The Institutional Review Boards at the sponsoring university and the community college from which the sample was drawn approved this study. We extended an invitation to the Psychology 110 course instructors to allow their students to participate during the course period. Psychology 110 is taken by most students at this community college as it is a general education class. Of the 21 contacted instructors, six agreed to participate. We collected data in 12 of 24 (50%) class sections as some instructors taught multiple sections.

We administered assessments during course periods. Research team members read aloud the information about the study, data collection process, and right to decline participation. The instructors left the room, and any students who preferred not to participate could leave anonymously (3 of 243). Next, we obtained students' informed consent and distributed packets of surveys to the remaining students. The questionnaires were randomized in these packets to reduce likelihood of order effects. We measured participants' blood pressure while they filled out the questionnaires. After completion of the data collection, participants were permitted to ask questions about the study and were given our contact information for any post-experimental inquiries.

Data Analysis Plan

One participant who responded carelessly (completed < 50% of all survey items or filling in the same answer throughout the surveys) was removed from analyses, leaving 242 participants. Next, the team examined the data for missingness discovering which data were missing at random (MAR). Given that only a small percentage of the data were missing (0.87%), the team selected Available Item Analysis (AIA), as it is a robust

approach for addressing missing data [44]. As per the guidelines [44], the team excluded participants if they did not complete at least 75% of the items in each questionnaire and all three blood pressure measures. Based on this criterion, 26 participants were excluded from the sample of 242 (10.7%), bringing the sample size to 216. After completing AIA, the team examined univariate and multivariate outliers. Univariate outliers were defined as any data point three or more standard deviations (SDs) from the mean [45] and multivariate outliers were calculated using Mahalanobis Distance, reducing the final sample size to 210. Finally, the team tested the assumptions of hierarchical regression analyses which were all fulfilled.

To evaluate the hypotheses, two linear regression models were calculated, one with DBP, and one with SBP as dependent variable. Our literature review demonstrated age [45–48], biological sex [46], BMI [45, 46, 48], family history of high blood pressure, heart disease and stroke [45], self-reported race/ethnicity [45, 46, 48], and smoking status [45, 48] are relevant covariates. Thus, both regression models were adjusted for the effects of these variables. In both regressions, the predictors were entered in three steps. The covariates were first entered, followed by the main effects of SSS and brooding, followed by the interaction effects between SSS and brooding.

Results

The correlations of SSS ($M = 4.67$, $SD = 1.75$) with brooding ($r = -.05$), SBP ($r = .04$), and DBP ($r = .07$) were all not significant. The correlation between brooding ($M = 2.31$, $SD = .71$) and SBP was significant ($r = -.15$; $p \leq .05$), but the correlation with DBP was not significant ($r = -.07$). SBP ($M = 114.58$, $SD = 16.15$) and DBP ($M = 73.98$, $SD = 9.70$) correlated significantly ($r = .67$; $p \leq .001$; see Table 1 for unadjusted models). After adjusting for the above listed covariates, as expected, the regression models revealed that the main effects of SSS and brooding and the SSS by brooding interaction predict DBP (Table 2). Contrary to our hypothesis, none of the tested effects significantly predicted SBP (Table 2). To examine the SSS by brooding interaction effect on DBP, we constructed model-implied graphs (Fig. 1). As expected, the graph shows that in individuals with low SSS, more brooding was associated with higher DBP. However, in individuals with high SSS, more brooding was associated with *lower* DBP. Exploratory analyses based on relevant literature [49] did not produce significant results.[1]

[1] Research [49] suggests that gender relates to brooding such that women are more likely to brood and to suffer negative consequences of brooding than are men. Thus, we conducted exploratory analyses to examine for effects of gender on the examined associations, which did not result in a significant gender effect.

Discussion

The current study examined the relations between SSS, brooding, and SBP and DBP through a diathesis-stress lens [38] based on depression literature [7, 8]. Results partially supported our hypotheses. To be more specific, lower SSS and more brooding were associated with higher DBP, but not SBP. Further, in individuals with low SSS, more brooding was associated with higher DBP, and in individuals with high SSS, more brooding was associated with *lower* DBP.

The latter finding is unexpected and suggests that diathesis theories focused on ruminative thought may be contextually specific (i.e., it might work for some populations, but not others). The experiences of individuals perceiving high SSS who also tended to brood may be related to additional factors that share construct overlap with brooding. One explanation might be that individuals perceiving high SSS who also tended to brood may have also engaged in reflection [25], effectively turning their brooding into problem-solving. However, reflection was not examined in the current study. Future research should simultaneously examine reflection and brooding, SSS, and SBP and DBP.

Another possible explanation for the link between high brooding and low DBP in participants experiencing high SSS may be found in the stress and problem-solving literature. Defensive pessimism is a coping strategy associated with the reduction of anxiety by preparing for future obstacles and negative outcomes, thus reducing current perceived stress [50, 51]. Studies have revealed that there are significant correlations between measures of defensive pessimism and brooding [52]. However, while brooding is generally linked to negative health effects, such as heightened DBP, defensive pessimism and the accompanying reduction in perceived stress has been related to several positive outcomes. Given the relatedness of the two constructs, it is plausible that defensive pessimism may have been a factor in the unexpected results we observed between brooding and DBP among high SSS participants. Thus, future research should examine both defensive pessimism and brooding in one study to examine their separate effects on DBP.

Temporal Level of Stressors and Diatheses

The temporal level of observed stressor and diathesis may have played a role in our findings such that state-induced activation of a stressor or diathesis, which occurs in the moment during experimental manipulation, had a differential effect from trait-like, which has a chronic, long-term course. We found no link between brooding and the brooding by SSS interaction with SBP. This might be explained by our examination of trait rather than state-induced SSS and brooding. There may be a

Table 1 Regression results with diastolic blood pressure and systolic blood pressure as dependent variables without covariates

Dependent variable	Diastolic blood pressure						Systolic blood pressure					
	Step 1		Step 2		Step 3		Step 1		Step 2		Step 3	
Predictors	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	B
SSS		.06− .07		.43+				.04		.15		
Brooding				.24				− .15*		− .05		
SSS by Brooding				-,48						− .15		
R^2 change	.093		.012				.025+		.001			
Total R^2	.093		.145				.025		.026			

difference between state versus trait SSS [37] such that SSS can be differentiated in terms of state or trait low-SSS. When experimentally manipulated as a state stressor, one study has shown that SSS is connected to SBP [37]. Two studies in addition to the present study have found that trait SSS is not linked to SBP [10, 53]. Similarly, there is a difference between state versus trait rumination [54], and they may be differentially related to SBP [6]. One prior study found no relation between SBP and trait rumination [55], but another [56] found a relation between trait rumination and SBP in a laboratory-induced stress task. One meta-analysis [6] found that SBP and state rumination were significantly related but did not compare trait versus state rumination when examining the effects of rumination on blood pressure. It also did not compare brooding versus reflection, instead relying on a single measure of sadness rumination. The results of prior findings, combined with those of the current study, suggest that the type of rumination (i.e., trait versus state) may play a role in its relation to SBP, but more research in this emergent area is warranted. Future research should address the possibility that state and trait types of SSS and rumination might have differential relations to SBP and DBP by examining both variables simultaneously.

Table 2 Regression results with diastolic blood pressure and systolic blood pressure as dependent variables with covariates

Dependent variable	Diastolic blood pressure						Systolic blood pressure					
	Step 1		Step 2		Step 3		Step 1		Step 2		Step 3	
Predictors	R^2	β	R^2	B	R^2	β	R^2	β	R^2	β	R^2	B
Age		.22***		.23***		.22***		.18**		.18**		.18**
Race		.03		.03		.03		.05		.05		.06
Native Language		− .07		− .07		− .10		− .07		− .07		− .07
Biological Sex		− .12+		− .12+		− .13*		− .47***		− .47***		− .48***
Alcohol		.02		.01		.01		.06		.05		.05
Smoking		− .05		− .06		− .04		.01		.01		.01
Hypertension		− .04		− .04		− .02		− .06		− .06		− .05
Heart Disease		.10		.10		.10		.08		.08		.08
Stroke		− .04		− .03		− .05		− .01		.01		− .01
BMI		.38***		.39***		.39***		.38***		.39***		.39***
SSS				.10		.59**				.02		.22
Brooding				.01		.42*				− .02		.14
SSS by Brooding						− .64*						− .26
R^2 change	.268***		.009		.021*		.416***		.001		.004	
Total R^2	.268		.277		.298		.416		.417		.421	

*N*ote. Hypertension, Heart Disease, Stroke = family history of hypertension, heart disease, stroke

DBP diastolic blood pressure, *SBP* systolic blood pressure, *SSS* subjective social status, *SES* socioeconomic status, *BMI* body mass index, *CVD* cardiovascular disease

+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

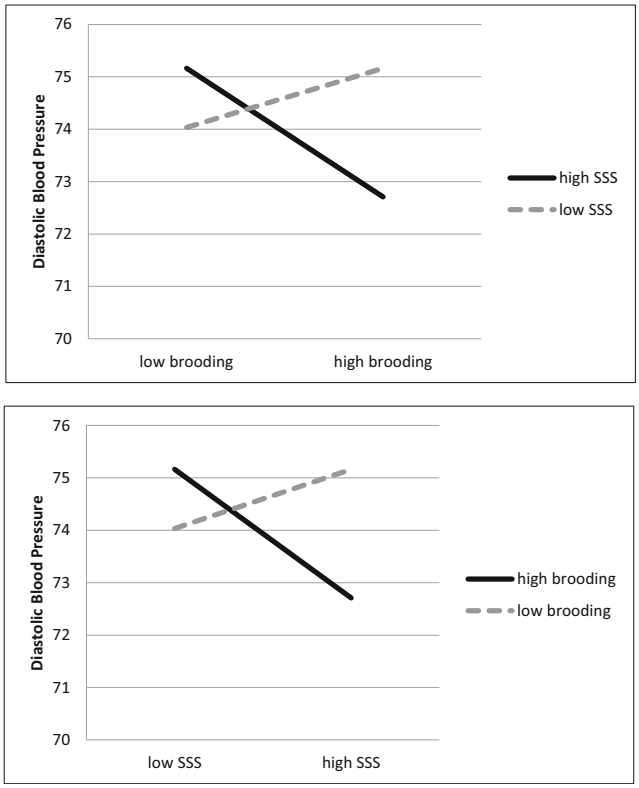

Fig. 1 Model-implied graphs for the effect of the subjective social status (SSS) by brooding interation on diastolic blood pressure

Strengths and Limitations

The current study had several strengths. This was the first study to examine the link between SSS and brooding with both SBP and DBP. Another strength of the study was that it contributed to the area of blood pressure research in which studies often measure blood pressure as a categorical, medically-based, diagnostic outcome (e.g., hypertension) [11]. Separating out SBP and DBP rather than using one combined category allowed for the examination of the connection between brooding, SSS, and DBP but not SBP, which may not have been possible by measuring hypertension categorically. This differentiation is important as DBP is typically linked to long-term health [57], even in individuals who do not meet full diagnostic criteria for hypertension [58].

Regarding limitations, the study was cross-sectional and used a college sample, which does not allow us to draw causal inferences across the larger US population [59]. Therefore, future studies should be experimental to move towards a causal model of the relation between SSS, brooding, and blood pressure with a more representative sample. Based on our discussion above, future research should consider additional factors (e.g., defensive pessimism) to get a fuller understanding of what was contributing to the link between SSS, brooding, and DBP. Another limitation relates to the measurement for blood pressure in that the current study used a single measurement, whereas ongoing, 24-hour monitoring of blood pressure may be warranted for future studies. A final limitation may be related to the outcome variables in that blood pressure is often a less accurate method of measuring cardiovascular activity when used alone than combined with other variables, like heart-rate variability and respiration rate [60]. So, in future research, those or similar methods of measuring cardiovascular activity should be included to provide a broader picture of cardiovascular reactivity in response to SSS and brooding.

Conclusion

As we predicted and in line with previous research [27], SSS and brooding were significantly associated with DBP in that lower SSS and higher brooding were linked to higher DBP. In terms of a diathesis-stress framework, brooding may be a diathesis for DBP. When an individual also perceives a stressor—in this case, low SSS—the result may be connected to increased wear and tear on the body. Given that DBP responds more to trait stress and is less reactive to state stress than SBP [53] and that DBP is arguably a sign of lingering underlying health issues [57], it is important for future research to replicate those of the current study and build upon them, studying trait and state SSS and brooding alongside SBP and DBP to better understand the development of CVD.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all participants in this study.

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