Health Psychology
1995, Vol. 14, No. 6, 556-562

0278-6133/95/$3.00

Appraisal Support Predicts Age-Related Differences in Cardiovascular Function in Women

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The influence of appraisal support on age-related differences in cardiovascular function was examined. Resting assessments of heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), respiratory sinus arrhythmia (RSA), and preejection period were obtained from 45 young and 20 elderly women. Consistent with prior research, results revealed that the elderly women had higher blood pressure and lower RSA than the young women. More important, appraisal support predicted age-related differences in SBP and DBP: Age predicted elevated blood pressure for women low in appraisal support, whereas age was unrelated to blood pressure for women high in appraisal support. These preliminary data suggest that appraisal support may be an important predictor of long-term physiological function and health.

Key words: social support, aging, cardiovascular function, physical health

Aging is typically associated with significant changes in cardiovascular function. Research on chronological age and physiological function, however, suggests that (a) physiological changes are not a biological invariant with aging (Smith, 1984) and (b) social factors may play a role in the aging process (Szklo, 1979; Uchino, Kiecolt-Glaser, & Cacioppo, 1992). The primary aim of this study was to examine the relationship between the appraisal dimension of social support and age-related characteristics of cardiovascular function in women.

Age-related changes in cardiovascular functioning are well documented (Lakatta, 1991). Resistance to blood flow tends to increase with age (Palmer, Ziegler, & Lake, 1978; Pfeifer et al., 1983). As a result, aging is typically associated with increases in resting blood pressure (Fleg, Tzankoff, & Lakatta, 1985; Steptoe, Moses, & Edwards, 1990). In addition, there is an age-related decline in the intrinsic heart rate (Jose, 1966; Jose & Collison, 1970). However, resting heart rate appears unaffected by aging (Garwood, Engel, & Capriotti, 1982; Ginter, Hollandsworth, & Intrieri, 1986). These data together suggest the possibility of age-related changes in the autonomic determinants of resting heart rate that compensate for age-related decreases in the intrinsic heart rate. Two of the most promising noninvasive measures of sympathetic and vagal activation of the heart are preejection period (PEP) and respiratory sinus arrhythmia (RSA), respectively (see Berntson, Cacioppo, & Quigley, 1993; Binkley & Boudoulas, 1986; Cacioppo et al., 1994).[1]

The available literature on age and the autonomic origins of cardiac chronotropy suggests that aging is associated with decreased vagal activity as indexed by RSA (Hrushesky, Schmitt, & Gilbertsen, 1984; Jennett & McKillop, 1971). Aging also appears to be associated with increased sympathetic activity as evidenced by increased plasma norepinephrine levels (Rubin, Scott, McLean, & Reid, 1982; Ziegler, Lake, & Kopin, 1976). Therefore, one might expect that aging would be associated with a shortening of PEP. However, studies of aging and PEP suggest a complex pattern: Between the ages of 30 and 60 years, PEP appears to be lengthened, but PEP tends to shorten thereafter (Montoye, Willis, Howard, & Keller, 1971; Shaw, Rothbaum, Angell, & Shock, 1973). These PEP changes may reflect a combination of age-related increases in sympathetic tonus (shortening PEP) as well as the effects of age-

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We would like to thank David Lozano for his expert technical assistance. This study was partially supported by Grants T32-MH18831 and MH44660 from the National Institute of Mental Health, a supplement to Grant MH42096 from the Office of Women's Health, the General Clinical Research Center Grant MO1RR0034, the Ohio State University Comprehensive Cancer Center core grant (Grant CA16058) from the National Cancer Institute, and Grant DBS9211483 from the National Science Foundation.

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[1] It is important to note that, although PEP is shortened by sympathetic activation, it is also shortened by increases in preload (i.e., left ventricular filling) and lengthened by increases in afterload (i.e., aortic diastolic pressure). Therefore, the interpretation of PEP as reflecting sympathetic activation may be complicated by changes in preload or afterload (e.g., Newlin & Levenson, 1979).

related decreases in preload or increases in afterload secondary to changes in blood pressure and vascular responses (lengthening PEP). One aim of the present research, therefore, was to examine the replicability of age-related differences in heart rate, systolic blood pressure (SBP), and diastolic blood pressure (DBP), and to provide additional data regarding age-related differences in RSA and PEP.

Although reliable age-related changes in cardiovascular function have been documented, such biological changes are not isomorphic with chronological age. For instance, blood pressure remains unchanged over relatively long periods of time in individuals from industrialized (Jenkins, Somervell, & Hames, 1983) and nonindustrialized (Fries, 1976; Mugambi, 1983) societies. Chronological age is superimposed on changes in social (e.g., social support), psychological (e.g., hostility), and behavioral (e.g., dietary) factors, each of which may have powerful moderating effects on cardiovascular functioning. A potentially important factor influencing the aging process is the quality of one's social relationships (i.e., social support). A large body of literature exists suggesting that individuals with poorer social relationships have higher rates of morbidity and mortality (Broadhead et al., 1983; House, Landis, & Umberson, 1988). Social support has also been shown to moderate physiological processes that may place an individual at risk for the long-term development of cardiovascular disorders (Gerin, Pieper, Levy, & Pickering, 1992; Kamarck, Manuck, & Jennings, 1990; Lepore, Allen, & Evans, 1993). Of particular importance to the current study are data indicating that perceived social support may moderate age-related differences in cardiovascular function. Uchino et al. (1992) found that individuals low in perceived social support showed an age-related increase in SBP; in contrast, individuals high in social support showed low and stable SBP across the ages.

Much of the prior literature on social support and physiological processes has conceptualized social support as a unidimensional construct and operationalized social support as general levels of social integration or overall perceptions of support. It is important to note that social support can be characterized by distinct functional components (S. Cohen & McKay, 1984; Cutrona & Russell, 1990), and an examination of relatively specific dimensions of social support may suggest more precise psychological and physiological mechanisms by which social relationships impact on health (Uchino, Cacioppo, Malarkey, Kiecolt-Glaser, & Glaser, 1995).

One important component of social support may be appraisal support, defined as the availability of others with whom to speak about one's problems (S. Cohen, Mermelstein, Kamarck, & Hoberman, 1985). S. Cohen et al. in their review of social support components found that appraisal support had beneficial effects across different stressors and situations. As noted by Cohen and colleagues, it is possible that appraisal support has important general effects on adjustment to life events because social networks assume a major role when one is required to assess the potential demands or threats posed by a situation (Carver, Scheier, & Weintraub, 1989; Festinger, 1954; Taylor, Buunk, & Aspinwall, 1990). As a result, one might expect appraisal support to have beneficial effects on adjustment or exposure to life events across the life span and to predict differences in cardiovascular function associated with chronological age. Therefore, a second aim of this study was to examine the potential influence of appraisal support on age-related differences in cardiovascular functioning.

Method

Participants

Forty-five young women (M age = 18.67 years, SD = 0.77) and 22 elderly women (M age = 66.86 years, SD = 4.31) were recruited to participate as part of a larger program project. The young women consisted of Caucasian undergraduates and were recruited through posted flyers to participate in a psychophysiological study. The elderly women (21 Caucasian and 1 African American) were recruited from the control group of the Ohio State University caregiver research project (see Kiecolt-Glaser, Dura, Speicher, Trask, & Glaser, 1991). All elderly women were postmenopausal and 27% were on estrogen replacement therapy.[2] On the average, the elderly women reported finishing college and had yearly incomes in the $20,000 to $29,000 range. Young women were paid $40 and elderly women were paid $75 for approximately 2.5 hr of participation in the study.

The inclusion criteria were as follows: (a) good health and normotensive; (b) no history of psychological disorder or chronic illness; (c) no cardiovascular prescription medication, nonprescription drugs, or tobacco products; (d) exercised less than 10 hr per week; (e) consumed less than 10 alcoholic beverages a week; and (f) not math, speech, or needle phobic. Technical problems resulted in the loss of cardiovascular data from 2 elderly participants. Heart rate and PEP data were also not available from 1 additional elderly participant. The degrees of freedom were adjusted accordingly.

Procedure

All participants were instructed before their appointment to (a) reschedule if they became ill or experienced a major negative life event (e.g., death in the family), (b) not consume any alcohol or take any nonprescription medication the day before the study, (c) refrain from any exercise the day before the study, and (d) refrain from eating or drinking anything but water after midnight of the test day. On arrival, informed consent was obtained, and an occluding cuff and four spot electrodes were placed for blood pressure and impedance cardiograph recordings. Following a 30-min adaptation period, a 6-min resting baseline of blood pressure and impedance cardiograph recordings were obtained in the seated position.[3] Following the study, partici-

[2] To examine the potential influences of estrogen therapy on cardiovascular function in elderly participants, we conducted two (estrogen therapy: no vs. yes) one-way analyses of variance (ANOVAs) on the cardiovascular measures. Results revealed no significant effects ($Fs < 1$). The relatively small number of elderly participants on estrogen therapy precluded using it as an additional between-subjects factor in the analyses. It is important to note, however, that the distribution of elderly participants in the low and high social support groups was relatively even (i.e., 2 and 4, respectively).

[3] As part of the larger program project, an 18-gauge indwelling catheter was inserted to examine endocrine and immune reactivity in response to acute psychological stress. The procedure for the baseline assessments reported in this article were identical for young and elderly participants. Different psychological stressors were used, however, for the young and elderly groups. As a result, the reactivity data for the psychological stressors across these two groups were excluded.

Table 1
Mean and Standard Error of Measurement Age-Related Differences in Cardiovascular Functioning

Group	SBP** (mm/HG)		DBP* (mm/Hg)		HR (bpm)		PEP (ms)		RSA**	
	M	*SEM*	*M*	*SEM*	*M*	*SEM*	*M*	*SEM*	*M*	*SEM*
Young	113.88	1.64	71.34	1.03	71.84	1.45	98.80	1.61	6.67	0.14
Old	128.52	4.09	78.36	2.64	68.01	2.01	95.46	4.17	5.01	0.28

Note. SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate; PEP = preejection period; RSA = respiratory sinus arrhythmia.
*$p < .01$. **$p < .001$.

pants completed the appraisal scale of the Interpersonal Support Evaluation List (S. Cohen et al., 1985).

Measures

Cardiovascular assessments. A Minnesota Impedance Cardiograph (Model 304B) was used to measure electrocardiogram (ECG), basal thoracic impedance (Z_0), and the first derivative of the impedance signal (dZ/dt). Disposable spot electrodes were placed in the tetrapolar configuration, as proposed by Qu, Zhang, Webster, and Tompkins (1986).[4] The two outer (current) electrodes were placed over the fourth cervical vertebra and the ninth thoracic vertebra, whereas the two inner (voltage) electrodes were placed 4 cm above the clavicle and over the sternum at the fourth rib. A 4 mA AC current at 100 kHz was passed through the two outer electrodes, and Z_0 and dZ/dt were recorded from the two inner electrodes. The ECG, Z_0, and dZ/dt were digitized at 500 Hz, and the interbeat intervals (IBIs) were derived from a custom software package.[5] The impedance data were ensemble averaged within 1-min epochs, and each waveform was verified or edited before analyses. PEP was quantified as the time interval in milliseconds from the onset of the ECG Q-point to the B-point of the dZ/dt waveform (Sherwood et al., 1990). Mean PEP was calculated by averaging across each of the 1-min resting assessments to increase reliability.

The IBIs were checked and edited for artifacts using the detection algorithm of Berntson, Quigley, Jang, and Boysen (1990). The IBI data were then converted to a time series of successive 500-ms samples. RSA amplitude was extracted as a noninvasive measure of cardiac vagal activity using a PC-based software package (MXedit 2.01, Delta-Biometrics, Bethesda, MD) with a bandpass of .12 to .40 Hz. The natural logarithm of the variance in heart period within the respiratory frequency (i.e., .12 to .40 Hz) served as the estimate of cardiac vagal activity (Porges & Bohrer, 1990). Mean RSA was calculated during the rest period by averaging across minutes.

A Cortronics Model 7000 continuous blood pressure monitor was used to assess SBP and DBP. An appropriate size occluding cuff was placed over the brachial artery and provided continuous blood pressure measurements at a constant cuff pressure of 20 mmHg.[6]

Appraisal support assessment. The appraisal subscale of the Interpersonal Support Evaluation List contains 10 questions and measures the perceived availability of others to speak with about one's problems (S. Cohen et al., 1985). S. Cohen et al. reported high internal consistencies and a 4-week test–retest reliability of .87 for the appraisal scale. In addition, the 6-month test–retest reliability of the appraisal subscale has been reported at .60 (S. Cohen et al., 1985).

Results

Preliminary Analyses

We performed a preliminary analysis to examine the independence of our blocking variables before investigating the specific aims of the study. A one-way (age: young vs. old) analysis of variance (ANOVA) was conducted on the measure of appraisal support to examine any potential age-related differences. Analyses revealed that elderly participants were characterized by lower levels of appraisal support compared with young participants, $F(1, 65) = 23.12, p < .001$ (M young = 5.09, $SD = 0.52$; M old = 4.27, $SD = 0.84$). Because of the collinearity between these variables, median splits were performed within each age group to form the orthogonal blocking variable of appraisal support. Therefore, 2 (age: young vs. old) × 2 (appraisal support: low vs. high) ANOVAs were subsequently conducted on the cardiovascular measures.

Age-Related Differences in Cardiovascular Function

Analyses revealed that elderly women were characterized by increased SBP, $F(1, 61) = 18.23, p < .001$, and DBP, $F(1, 61) = 9.75, p < .01$, whereas no age-related difference in resting heart rate was found, $F(1, 60) = 2.13$, *ns* (see Table 1). These results are consistent with prior research.

[4] The focus of our study was on the assessment of the systolic time intervals (i.e., PEP). Spot electrodes measure the systolic time intervals at comparable reliabilities to band electrodes (Sherwood, Royal, Hutcheson, & Turner, 1992) but are more convenient and comfortable for participants.

[5] We thank Robert Kelsey and William Guethlien for providing us with copies of their data acquisition and reduction software for impedance cardiography and for their helpful advice.

[6] Because of the relatively new technology of the Cortronics blood pressure monitor, we have been careful to monitor the reliability of the Cortronics by periodically checking it against readings from a standard occillometric monitor, a mercury sphygmomanometer, or both. In the rare case that the Cortronics needed recalibration, we sent it back to the manufacturer for maintenance. Our ability to replicate research within and across laboratories on stress-induced changes in blood pressure (e.g., Cacioppo et al., 1995; Knapp et al., 1992; Uchino, Cacioppo, Malarkey, & Glaser, in press) and age-related differences in blood pressure (e.g., Uchino et al., 1992) gives us confidence in the reliability of the Cortronics Model 7000 monitor.

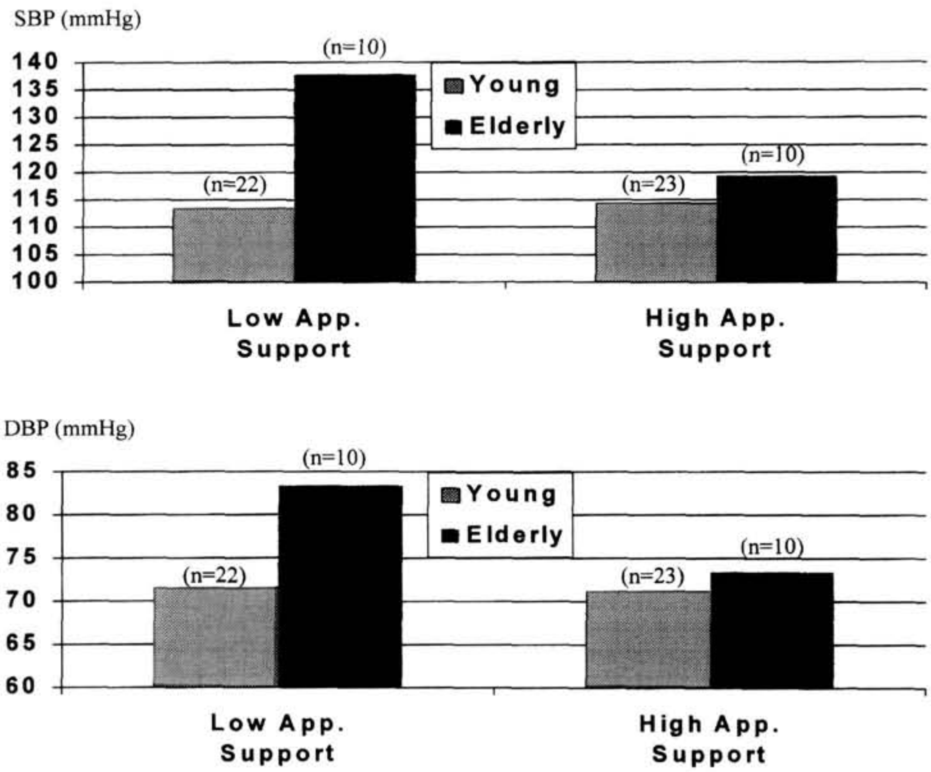

Figure 1. Mean age-related differences in resting systolic blood pressure (SBP; top panel) and diastolic blood pressure (DBP; bottom panel) as a function of appraisal (App.) support.

Analyses examining age-related differences in the noninvasive indexes of autonomic control of the heart revealed a significant age-related decrease in RSA, $F(1, 61) = 33.32, p < .001$. These data suggest that decreases in the intrinsic heart rate with aging is compensated, at least in part, by decreases in vagal control of the heart. In contrast, there was no evidence for age-related differences in PEP ($F < 1.05$). However, age-related increases in blood pressure may have masked changes in cardiac sympathetic control as indexed by PEP (i.e., increased afterload associated with higher DBP).

Appraisal Support and Age-Related Differences in Cardiovascular Function

Analyses were next conducted to examine the relationship between appraisal support and cardiovascular functioning in the young and elderly women. Results revealed a main effect for appraisal support on SBP, $F(1, 61) = 6.53, p < .02$, and DBP, $F(1, 61) = 5.24, p < .03$. Individuals high in appraisal support evidenced lower resting SBP (M low = 121.03, M high = 115.82) and DBP (M low = 75.21, M high = 71.85) compared with individuals low in appraisal support. More important, significant interactions between age and appraisal support were found for resting SBP, $F(1, 61) = 7.90, p < .01$, and DBP, $F(1, 61) = 4.56, p < .04$ (see Figure 1).[7] Subsequent analyses revealed that age predicted elevated SBP, $F(1, 30) = 24.96, p < .001$, and DBP, $F(1, 30) = 12.74, p < .002$, for individuals low in appraisal support. In contrast, age was unrelated to SBP and DBP for individuals high in appraisal support ($Fs < 1.10$).[8]

Finally, a significant interaction was found between age and

[7] We repeated our analyses using moderated regression procedures and treated appraisal support as a continuous instead of a dichotomized variable. Inspection of the scatterplots, however, revealed several outliers that effectively served to weaken the results of the moderated regression analyses. Importantly, regression procedures are relatively more sensitive to such outliers compared with ANOVAs with median splits. As a result, the interactions between age and appraisal support for SBP and DBP were nonsignificant using moderated regression procedures. Nevertheless, the pattern of the interaction was identical to that depicted in Figure 1.

[8] We examined the influence of body mass on the significant Age × Appraisal Support interactions for SBP and DBP. Body mass index was calculated using the quetelet index: kg/m^2. Results of the analyses of covariance (ANCOVAs) revealed that statistically controlling for body mass did not alter the significant interactions for SBP ($p = .01$) or DBP ($p = .02$). An important assumption of the ANCOVAs is homogeneity of regression slopes (J. Cohen & Cohen, 1983). The presence of a significant interaction between the covariate and the between-subject factors would render the ANCOVAs invalid. The three-way interaction between age, appraisal support, and body mass was nonsignificant for SBP ($p > .18$). However, the three-way interaction was significant in the analyses of DBP ($p < .05$), thereby invalidating this ANCOVA.

appraisal support for PEP, $F(1, 60) = 4.05$, $p < .05$.[9] Subsequent analyses of simple main effects revealed that individuals high in appraisal support showed a tendency toward an age-related shortening of PEP, $F(1, 30) = 3.23$, $p < .09$, as would be expected if aging was associated with increased sympathetic control of the heart. Although one might expect that individuals low in appraisal support would evidence even greater age-related increases in sympathetic control of the heart, we found no evidence to this point ($F < 1$).[10]

Discussion

Aging is associated with important changes in cardiovascular function that confer increased risk for cardiovascular disorders. However, the use of age alone to predict cardiovascular problems usually results in a high rate of false positives. Leon (1987) has emphasized the importance of examining age in conjunction with other potentially modifiable risk factors to improve the prediction, detection, and treatment of cardiovascular diseases. Our data indicate that appraisal support may be an important predictor, if not contributor, to physiological processes that place individuals at risk for cardiovascular disorders (also see Uchino et al., 1992). Thus, an understanding of biological aging, with implications for intervention, may be incomplete without consideration of social factors that predict such changes across the life span.

It is important to consider the potential mechanisms underlying the prediction of age-related differences in blood pressure by appraisal support. According to Kenney (1989), "Aging may be defined as the sum of all changes that occur . . . with the passage of time and lead to functional impairment and death" (p. 15). If one conceptualizes social support as a stable individual-difference variable (e.g., Sarason, Sarason, & Shearin, 1986), then lower levels of social support may be associated with relatively poorer adjustment to life events, greater exposure to negative events across the life span (Russell & Cutrona, 1991), or both. The net effect of such processes across the years may be to biologically age the individual at a faster rate. Nevertheless, our preliminary data are limited by the (a) cross-sectional design and (b) relatively small number of participants. Future research might use a longitudinal design with a larger sample.

In the present study we used the relatively specific dimension of appraisal support, whereas in our earlier work we used a combined index of social support. S. Cohen et al. (1985) found that appraisal support was a consistent predictor of better outcomes across different stressors, whereas they found that the effects were more stressor specific for other dimensions of social support (e.g., belonging, tangible). Consistent with the observations by Cohen and colleagues, we previously found appraisal support to be a relatively stronger and more reliable predictor of resting immune function than belonging, tangible, and self-esteem support (Uchino et al., 1995). In the present study we found appraisal support to be a predictor of age-related differences in blood pressure; therefore, it is possible that the associations obtained in Uchino et al. (1992) may be primarily due to the effects of appraisal support. Time limitations precluded the assessment of multiple dimensions of social support in the present study. Thus, future research should examine multiple dimensions of social support to examine the specificity of the effects reported in this study.

An important conceptual benefit of examining specific measures of social support is that it may suggest more precise mechanisms by which social support may impact on health. In contrast, an examination of overall social support is relatively nonspecific in terms of suggesting mechanisms. Appraisal support is defined as the availability of others to speak with about one's problems. Therefore, one mechanism by which appraisal support may be associated with beneficial outcomes is through self-disclosure. Pennebaker (1989) suggested that one reason self-disclosure may be beneficial is that it allows individuals to understand and assimilate traumatic and stressful events. Talking with others may also provide social comparison information and reduce intrusive or ruminative thinking. Appraisal support, therefore, may be important because it provides an individual with the opportunity to discuss, disclose, and compare one's personal problems during the life span. Importantly, items on the appraisal subscale appear to correspond with such a disclosure mechanism (e.g., "There is someone whom I feel comfortable going to for advice about very intimate problems" or "I feel that there is no one with whom I can share my most private worries and fears"), and S. Cohen et al. (1985) reported that appraisal support was significantly correlated with a measure of self-disclosure ($r = .40$). Knowing the mechanisms responsible for the effects of appraisal support may suggest interventions to improve long-term health. For instance, interventions might be aimed at the development and maintenance of long-term friendships and stable familial relationships as sources for appropriate self-disclosure.

There are several potential limitations of the present study related to our participant sample. First, we tested only women, and women generally tend to self-disclose at higher levels than men (Dindia & Allen, 1992). It is important to note that this sex difference does not indicate that self-disclosure is more beneficial for women than men. Indeed, studies examining the effects of self-disclosure on physiological processes have typically found uniform effects using both men and women (Esterling, Antoni, Kumar, & Schneiderman, 1990; Pennebaker, Kiecolt-Glaser, & Glaser, 1988). In addition, the literature on social support and health suggests that men may benefit more than women (Shumaker & Hill, 1991). Therefore,

[9] To examine the influence of body mass on the Age × Appraisal Support interaction for PEP, we repeated our analyses and statistically controlled for the body mass index. Results revealed that the Age × Appraisal Support interaction was now marginally significant ($p = .07$). In addition, the Age × Social Support × Body Mass interaction was not significant ($p > .55$). The minimal change in the p level, however, is probably attributable to (a) missing body mass index data for 2 participants and (b) the decreased power associated with the use of a covariate.

[10] The hypothesis that individuals low in appraisal support would evidence greater age-related increases in cardiac sympathetic control could not be evaluated unequivocally because of age-related differences in blood pressure. It is important to note, however, that individuals high in social support showed less evidence of this age-related increased sympathetic activity (as indexed by blood pressure) than individuals low in social support.

one might expect that the effects reported in this study would be equivalent, or perhaps stronger, in men. However, it is important to directly examine the generality of these effects in future research.

Second, we limited the present investigation to a normotensive population. One question thus relates to the potential effects of social support on blood pressure regulation in hypertensive populations. In this regard, intervention studies that have examined the utility of social support from a significant other (i.e., spouse) in controlling hypertension have revealed beneficial effects on subsequent blood pressure regulation (Levine et al., 1979; Morisky et al., 1983). The mechanisms responsible for these effects may be distinct, however, from those operating in normotensive populations. The effects of social support on blood pressure regulation in hypertensives may be due to health-related factors related to greater patient adherence to medical regimens (Levine et al., 1979). In contrast, studies examining the effects of social support in normotensives suggest that such health-related behaviors do not account for the beneficial effects of social support on blood pressure (Bland, Krogh, Winkelstein, & Trevisan, 1991; Janes & Pawson, 1986). Therefore, psychosocial factors related to perceptions of stress or controllability may be important longer term mechanisms underlying the cross-sectional relationships in the present study.

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