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A Friendly Dog as Potential Moderator of Cardiovascular Response to Speech in Older Hypertensives

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ABSTRACT As the population ages and obesity increases, the number of older adult hypertensives is rising dramatically. Uncontrolled hypertension (HTN) increases, and reducing blood pressure (BP), lowers cardiovascular, cerebrovascular, and renal morbidity and mortality. Cardiovascular reactivity, defined as exaggerated cardiovascular responses to various stressors, is associated with the development and progression of HTN and associated morbidity and mortality. Speaking is a social stressor, occurring frequently in daily life, that is accompanied by significant surges in BP. The current project was designed as a preliminary study to evaluate whether friendly dogs may be an effective intervention for moderating cardiovascular stress responses in older adult hypertensives. Cognitively intact, community-living older adults (n = 11) with resting BPs in the pre- to mild hypertensive range (120–150/80–100 mmHg) participated in the study. The quiet-talk-quiet (QTQ) protocol was used to assess BP responses to speaking. The QTQ protocol, consisting of sitting silently for two minutes, talking for two minutes, and sitting silently for two minutes was repeated twice, once with an unfamiliar, friendly dog in the room, once without the dog. The dog was randomly assigned to be present either for the first or the second QTQ. An ANOVA or ANCOVA with repeated measures three-way interaction between dog presence (dog in, dog not in), activity (quiet, talk), and order (dog in first, no dog in first) was used to examine the moderating effect of the presence of the dog on cardiovascular reactivity to speaking; it was significant for diastolic BP ($F_{(1,9)}$ = 12.8, p = 0.006), and tended to be significant for systolic BP ($F_{(1,8)}$ = 4.4, p = 0.12). During speech, BP was (7/2 mmHg) lower when the dog was present than when it was not present. BP while sitting quietly did not differ according to the presence of a dog. Pets might provide a viable means of decreasing BP surges during stressful activities in older hypertensives.

Keywords: blood pressure, cardiovascular reactivity, companion animals, elderly, hypertension, talk, older adults, pets, speech, stress response

As the population ages and obesity increases, the number of elderly hypertensives rises dramatically (Fields et al. 2004). In the US, the prevalence of hypertension (HTN) increases with advancing age. About 26 million people in the US over age 65 are hypertensive (Fields et al. 2004; Population Division U.S. Census Bureau 2005). In individuals 60 to 79 years old, 63% are hypertensive, and among those over 80 years old, nearly 74% are hypertensive (Lloyd-Jones, Evans and Levy 2005). Blood pressure (BP) control is poor among older adults, especially women. Women account for 59% of the US population aged 65 years and older (Population Division U.S. Census Bureau 2005). In women, failure to control HTN increases with age, from 62% for those less than 60, to 77% for those greater than 80 years old; in men it remains 62% in both age groups (Lloyd-Jones, Evans and Levy 2005).

Uncontrolled HTN leads to increased cardiovascular and renal morbidity and mortality (Elliott and Black 2002; Chobanian et al. 2003). For every 20 mmHg increase in systolic BP (SBP) or 10 mmHg rise in diastolic BP (DBP), mortality from myocardial infarction, heart failure, stroke and kidney disease doubles (Chobanian et al. 2003).

In older adults, increasing BP is associated with increased risk of cardiovascular disease. In a community sample of those 80 years of age or older, major cardiovascular events occurred in 9.5% of normotensives, 19.8% of pre-hypertensives, 20.3% of stage 1 hypertensives, and 24.7% of the stage 2 or treated hypertensives (Lloyd-Jones, Evans and Levy 2005).

Reduction in BP lowers cardiovascular, cerebrovascular, and renal mortality and morbidity (JNC 1997; Elliott and Black 2002; Chobanian et al. 2003). Achievement of lower BP is the most important therapeutic goal in the older hypertensive population (Elliott and Black 2002). Treatment of HTN is aimed at reducing cardiovascular and renal morbidity and mortality by achieving SBP below 140 and DBP below 90 mmHg (Chobanian et al. 2003). Any reduction in BP has significant benefits for older adults (Elliott and Black 2002; Chobanian et al. 2003).

Mental stress contributes to elevated BP and the development of HTN (Rozanski, Blumenthal and Kaplan 1999; Gerin et al. 2000; Sterling 2003; Strike and Steptoe 2003). Current research shows that cardiovascular reactivity, defined as exaggerated cardiovascular responses to various stressors, is associated with the development of HTN as well as with HTN-associated morbidity and mortality. Repeated, exaggerated BP responses to psychological and physical stressors lead to higher BP set points and thus to the development of HTN (Gerin et al. 2000). Cardiovascular reactivity causes arterial damage which in turn leads to coronary heart disease and cerebrovascular accidents (Gerin et al. 2000; Carroll et al. 2001; Everson et al. 2001).

Speaking is a social stressor, occurring frequently in daily life, which is accompanied by significant surges in BP. The effect of giving a speech in front on an audience (Thomas et al. 1984a; Fontana et al. 1999; Glynn, Christenfeld and Gerin 1999; Christenfeld and Gerin 2000), reading aloud (Friedmann et al. 1982; Long et al. 1982; Friedmann et al. 1983; Thomas et al. 1984b; Thomas and Friedmann 1994), or discussing a stressful topic (Rozanski et al. 1988; Blumenthal et al. 1995; Becker et al. 1996; Jiang et al. 1996; Goldberg et al. 1996; Le Pailleur et al. 2001; Fritz, Nagurney and Helgeson 2003) is major BP surges. Blood pressure and HR increase 10 to 50% when talking or reading aloud (Lynch et al. 1980; Lynch et al. 1981; Malinow et al. 1982). This response has been demonstrated consistently in various settings including the home (Friedmann et al. 1982; Friedmann et al. 1983), workplace (Thomas et al. 1984a), and laboratory (Lynch et al. 1980; Long et al. 1982; Lynch et al. 1982; Freed et al. 1989). The increases in BP and HR during talking and reading have been recorded in diverse populations including children (Lynch et al. 1982; Friedmann et al. 1983; Thomas et al. 1984b), normotensive adults (Lynch et al. 1981; Friedmann et al. 1982; Long et al. 1982; Lynch et al. 1982; Malinow et al. 1982; Thomas et al. 1984a; Thomas and Friedmann 1990; Thomas et al. 1992; Thomas and Friedmann 1994), cardiac patients (Lynch et al. 1982; Wimbush et al. 1986; Freed et al. 1989; Thomas and Friedmann 1990), and hypertensive adults (Lynch et al. 1981; Lynch et al. 1982).

Blood pressure increases during speech are significantly correlated with resting BP: the higher the resting BP, the greater the increases in BP during speech. Increases in BP during speech are

greater for hypertensive—even those taking anti-hypertensive medication—than for normotensive individuals (Lynch et al. 1981). Blood pressure responses to talking have not been found to be blocked by therapeutic doses of anti-hypertensive medication (Lynch et al. 1981; Lynch et al. 1982; Freed et al. 1989; Thomas and Friedmann 1994; Le Pailleur et al. 2001).

Older patients experience greater increases in BP during speech than young patients. Age was correlated ($r = 0.425$, $p < 0.001$) with the magnitude of the SBP increase during speech in 23 men and 16 women (mean age = 54.2 years) with angiographically documented cardiac disease (Freed et al. 1989). Blood pressures of 29 adults without heart disease (45–73 years old) increased significantly when they spoke about a distressing topic. The magnitude of the increase in SBP was related to age: the older the individual, the larger the increase. The mean BP increase for 64–73-year-old participants during speech was 40/16 mmHg (Becker et al. 1996). In a study by Le Pailleur et al. (2001), blood pressure increased more while 64 patients with essential HTN (50% female, $M = 59$ years) spoke about their hypertensive history and other medical conditions (19/13mmHg) than when they counted aloud (4/5mmHg). Increases were similar for both treated and untreated hypertensives. The number of anti-hypertensive medications was not related to the magnitude of the increases. Among 79 normotensive undergraduate students, BP increased significantly (11/10 mmHg) while they talked about a problem (Fritz, Nagurney and Helgeson 2003).

Social support buffers the stress response during speech (Allen et al. 1991; Gerin et al. 1995; Christenfeld et al. 1997; Kamarck, Peterman and Raynor 1998; Allen, Blascovich and Mendes 2002). Speaking in public to a supportive audience results in lower BP reactivity than when speaking to a non-supportive audience.

Prior experience with the supportive person enhances the effect of the supportive person's presence on the moderation of the stress response. Women's ($n = 90$) SBP increases during speech were lowest when speaking in front of a supportive female friend (7.9 mmHg) and highest when speaking in front of a non-supportive female stranger (22.9 mmHg). The magnitude of the responses was intermediate when speaking in front of a non-supportive female friend or a supportive female stranger (Christenfeld et al. 1997). In a study of 57 women and 52 men, the gender of the supportive person had a significant impact on the SBP response during speech. Both men and women speakers responded similarly to female support (Glynn, Christenfeld and Gerin 1999). A supportive woman reduced women's and men's stress responses, but a supportive man did not. A woman's presence may define the situation as less threatening and thereby result in reduced physiological responses to stressors.

The presence of a friendly dog has been found to moderate BP reactivity to a social stressor in children (Friedmann et al. 1983; Nagengast et al. 1997), young adults (Friedmann et al. 1983; Wilson 1987; Friedmann, Locker and Lockwood 1993; Nagengast et al. 1997; Allen, Blascovich and Mendes 2002), and young adult hypertensives (Allen, Shykoff and Izzo 2001). For example, the presence of a friendly dog decreased young adults' and children's BP responses to reading aloud. In a study of 45 women's ($M = 39$ years old) cardiovascular (CV) stress responses, the presence of a dog led to reduced CV reactivity compared with the presence of another person, even when the person was chosen by the subject to provide support (Allen et al. 1991). In Friedmann and Thomas' study of BP responses of 38 children (9–16 years, $M = 12.2$ years), BP increases during reading aloud were significantly lower when a friendly dog was present than when it was not. BPs were also significantly lower on average when the dog was present for the first rather than the second half of the protocol (Friedmann et al. 1983). This finding is remarkable because the children had normal BPs, were in a familiar home environment, and asked to complete a mildly stressful task. The dog used in the study did not belong to any of the participants and had never been introduced to them prior to the study. In a similar study of college students, the CV responses to reading aloud with a dog present differed according to perceptions of dogs. Students who viewed dogs more positively had lower BP responses when the dog was present than those who viewed dogs less positively (Friedmann, Locker and Lockwood 1993). The dog used in this study also did not belong to any of the participants and had never been introduced to them prior to the study.

Acquiring a dog reduced CV reactivity of Stage II+ hypertensives (resting BP > 160/100) who worked in a high-stress occupation and lived alone (Allen, Shykoff and Izzo 2001). The effect of pets on reactivity was examined by comparing reactivity of patients who were randomly assigned to begin taking angiotensin converting enzyme (ACE) inhibitors (n = 24) and to adopt pets with reactivity of patients assigned to begin taking ACE inhibitors but were not assigned to adopt pets (n = 24) (Allen, Shykoff and Izzo 2001). While cardiovascular reactivity did not differ prior to group assignment, cardiovascular reactivity in response to two stressors, speech and mental arithmetic, was lower six months later in those assigned to adopt pets than in those who were not. ACE inhibitors reduced resting BPs in both groups. Social support through pet ownership lowered BP responses to mental stress six months later (Allen, Shykoff and Izzo 2001).

A study of animal-assisted therapy (AAT) compared a therapy dog lying in bed beside a hospitalized heart-failure patient for 12 minutes with its handler in the room with a 12-minute visit by a person only and 12-minute period without a visitor. The 76 patients were randomly assigned to one intervention. Epinephrine, a stress indicator, dropped 17% from before to after the dog's visit and 2% for the person-only visit; it rose 7% when there was no visitor. Left atrial BP measured with a pulmonary wedge, decreased by 2.1 mmHg (10%) after the dog's visit, and increased by 3% and 5%, respectively, after the person-only visit and no visit (Cole, Gawlinski and Steers 2005).

Pet ownership is related to decreased mortality (Friedmann et al. 1980; Friedmann and Thomas 1995). In two epidemiological studies, Friedmann and Thomas documented the long-term benefits of pet ownership for survival of post-myocardial infarction (MI) patients. The first prospective study examined one-year survival of 92 patients admitted to a coronary care unit. Pet owners were significantly more likely to be alive one year later than non-owners. Multivariate analysis revealed that pet ownership made a significant contribution to one-year survival beyond the effects of other physiological predictors of survival and of human sources of social support (Friedmann et al. 1980). More recently, these findings were confirmed and extended in a prospective study of 369 post-MI patients with ventricular arrhythmias, aged 35 to 83 (M = 63) years, who were enrolled in the Cardiac Arrhythmia Suppression Trial (CAST). Pet ownership was a significant independent predictor of one-year survival, independent of physiological predictors of survival, including left ventricular ejection fraction, Type II diabetes, and social support. In a parallel set of analyses, dog ownership was a significant independent predictor of survival. Dog owners were approximately seven times more likely to survive one year than people who did not own dogs (Friedmann and Thomas 1995).

Pet ownership also has been related to better cardiac function (Friedmann et al. 2003) in patients with coronary artery disease (CAD). In 102 patients enrolled in the CAST study, heart rate variability (HRV) was higher, indicating lower risk of cardiac mortality, for pet owners than non-owners and for dog owners than those who did not own dogs (Friedmann et al. 2003). While low HRV is associated with depression in post-MI patients (Carney et al. 2001; Carney et al. 2005; Carney, Freedland and Veith 2005), the differences in HRV between pet owners and non owners were not due to differences in depression.

A friendly animal provides non-judgmental support that can stimulate relaxation better than another person (Friedmann and Thomas 1985; Allen, Blascovich and Mendes 2002; Pickering 2003). Decreasing environmental stress reduces stress responses and thereby reduces cardiovascular morbidity and mortality (Gerin et al. 2000; Sterling 2003; Schwartz et al. 2003). Similarly to the case of the presence of a supportive woman, the presence of a friendly animal defines a situation as less stressful (Lockwood 1983; Friedmann and Lockwood 1991; Rossbach and Wilson 1992) and thereby may result in reduced physiological responses to stressors. Two studies of college students' responses to drawings or pictures with and without animals, demonstrate that people rate pictorial scenes and the people depicted in them as significantly more friendly (Lockwood 1983), less threatening (Lockwood 1983), happier (Lockwood 1983; Rossbach and Wilson 1992), safer

(Rossbach and Wilson 1992), and more relaxed (Rossbach and Wilson 1992) than when the animals are not present. Physiological evidence also indicates that a dog defines a situation as less stressful. Overall, BPs of children were lower when a friendly dog was present in the home at the beginning of an experiment involving reading aloud than if the dog was present in the room during the second half of the experiment (Friedmann et al. 1983).

The presence of a pet or friendly animal has the potential to reduce BP in older adult hypertensives and to moderate cardiovascular reactivity during stressful activities. However, the majority of the research addressing the impact of animals on BP or BP reactivity has been conducted in young adults or children. Older adults, particularly those who are hypertensive, are especially vulnerable to the impact of stress responses on cardiovascular-related morbidity and mortality. This study is the first evaluation of the stress ameliorating effects of a friendly animal on CV stress responses in older adults. It was designed as a preliminary study to evaluate whether a friendly animal may be effective at reducing cardiovascular stress responses in this extremely vulnerable population. It also was intended to evaluate whether the findings from younger populations could be generalized to older adult hypertensives. Therefore, its methodology was modeled after previous studies in younger and healthier populations.

Methods

Participants

Independent-living seniors attending a community-based exercise program or living in a continuing-care retirement community were invited to participate in the study. They were informed that they had an opportunity to participate in a study of BP changes in individuals with high normal blood pressure or mild hypertension. Invitations were issued to seniors during their personal visits to exercise classes or contacts with medical personnel in the continuing-care retirement community. In either case, seniors were then contacted by telephone by study personnel to confirm their interest in the study and to explain it more fully.

The likelihood that volunteers would be eligible for the study was ascertained by study personnel during the telephone contacts. Volunteers were asked if they would be interested in participating in a study of BP in older adults and were asked which medications they took. They were asked if they would mind if a dog was present in the room with them, and if they were allergic to animals. If they were interested, did not take Coumadin® or a similar anti-coagulant, and did not mind being in a room with a dog, the study was explained further and verbal informed consent for BP screening was obtained, and BP screening was scheduled.

Procedure

Two blood pressure screenings, one week apart, were conducted according to the protocol for diagnosis of hypertension (Chobanian et al. 2003) to confirm that the BPs of the participants were within the targeted range(120–150/80–100 mmHg). Screenings were conducted by appointment in a private room or office. Potential participants were asked not to partake in nicotine, caffeine or alcohol for at least two hours prior to attendance. At the first screening, written informed consent for screening was obtained. The volunteer was asked to sit quietly in a chair for five minutes before BP screening. An appropriately sized BP cuff was placed on the non-dominant arm. Blood pressure was recorded three times, two minutes apart using a Dinamap 845X BP monitor. If two of the three readings (either systolic or diastolic) fitted established criteria for pre- or Stage 1 HTN (Chobanian et al. 2003), the potential participant was screened for cognitive impairment using the Mini-Mental State Examination (Folstein, Folstein and McHugh 1975). If it did not indicate cognitive impairment (score of 25 or above), the potential participant was invited to participate in a second screening. A second BP screening, with the same protocol, took place at least one week after the first screening. If two of the last three readings were between 120–150/80–100 mmHg, the volunteer was eligible for the study. If the volunteer met the BP and cognitive status requirements for the study, demographic and

health history information were obtained, medication information was checked to confirm that no anticoagulant medication was being used, written informed consent for the project was obtained, and the study was scheduled.

The quiet-talk-quiet (QTQ) protocol was used to assess BP responses to speaking in the participant's living room (n = 8) or in a faculty office (n = 3). The QTQ protocol consists of sitting silently for two minutes, talking for two minutes, and sitting silently for two minutes. In this case, participants were asked to talk about their usual daily activities. The participants completed the QTQ protocol in two consecutive series, once with a friendly dog present and once without a friendly dog present. Participants were randomly assigned to have the friendly dog present during the first or the second QTQ series. During the QTQ sessions, BP was assessed with a Dinamap 845X automated oscillometric BP monitor once per minute. The researcher was present in the room throughout the entire experimental assessment. When the dog was present, he sat or lay near the participant but did not touch the participant during the sessions.

Instruments

The Dinamap 845X oscillometric BP monitor was used to obtain BPs during the screenings and during the experimental study. The BP monitor automatically inflates at intervals set by the researcher. During the screening, the equilibration period, and the experimental protocol, the monitor inflated at one-minute intervals and printed BPs after each measurement. The validity and reliability of the Dinamap 845X are well established (Ramesy 1979; Yelderman and Ream 1979) and the instrument has been used in many studies examining BP responses to stressors (Lynch et al. 1980; Lynch et al. 1981; Friedmann et al. 1982; Lynch et al. 1982; Friedmann et al. 1983; Thomas et al. 1984a).

The Mini-Mental State Examination (MMSE) was used to assess the cognitive status of volunteers during the BP screening. Folstein and McHugh (1975) devised this tool for serial testing of patients' cognitive status on a neurogeriatric ward and for consecutive hospital admission. It is the most widely used brief, cognitive screening tool. The test has been validated in samples of older adult individuals with and without dementia or psychiatric disorders. Test-retest reliability over 24 hours was 0.887. Concurrent validity was established by correlation with the Verbal IQ and Performance IQ of the Weschsler Adult Intelligence Scale (r_s = 0.776 and 0.660, respectively; Folstein, Folstein and McHugh 1975). The MMSE is sensitive to changes in mental status.

The friendly dog used in this study was a small (25 pounds), tan-colored, neutered, male dog with rooted hair. Dogs with this type of coat are less likely to cause allergic responses than dogs that shed. The dog was up-to-date with inoculations and remained under the control of the researcher at all times. He sat or lay near the participant, but did not touch the participant during the experimental sessions. None of the participants had met the dog prior to the study.

Data Analysis

Despite randomly assigning participants to the "dog in during the first QTQ" or "dog in during the second QTQ" groups, differences in age and screening BPs between the two groups were analyzed with t-tests. Separate analyses were conducted for each of the dependent variables. Analyses of covariance with repeated measures were planned to examine the effects of the presence of the dog on BP responses to speech. The three-way interaction between dog (dog in, dog out), activity (quiet, talk), and order (dog in first QTQ, dog in second QTQ) was used to evaluate whether the presence of the dog moderated the cardiovascular stress response. The covariate was planned as the respective screening BP. The criteria for covariates in analyses of variance include a relationship with the outcome variable and differences in the variable between the groups, in this case dog in first QTQ and dog in second QTQ. For the current data, the criteria were met for SBP but not for DBP. Thus, analysis of covariance with repeated measures was used for DBP, and analysis of variance with repeated measures was used for SBP.

Table 1. Demographic and health characteristics of participants (n = 11).

Characteristic	Number (%)	Mean (*SD*)
Age (years)		81.3 (5.59)
Mini-Mental State Examination Score		29.7 (0.65)
Screening Blood Pressure (mmHg)		137.2 (9.4)/68.6 (9.5)
Gender		
Female	10 (90.9)	
Male	1 (9.1)	
Race / ethnicity		
Black	2 (18.2)	
White	9 (81.8)	
Marital Status		
Single	1 (9.1)	
Widowed	7 (63.6)	
Married	3 (27.3)	
Lives Alone	7 (63.6)	
Diagnoses		
Hypertension	3 (36.4)	
Heart Disease	3 (27.3)	
Angina	0 (0)	
Heart Failure	0 (0)	
Coronary Artery Bypass Surgery	1 (9.1)	
Myocardial Infarction	0 (0)	
Diabetes Mellitus	1 (9.1)	

Results

A total of 11 community-living, older adults aged 65–94 (M = 81.3, SD = 5.59) years were recruited to participate in the study; four owned pets (three cats, one other), seven did not. No participant owned a dog. The demographic and health characteristics of the participants are included in Table 1. Only three patients indicated that they had a medical diagnosis of hypertension. However, seven of the 11 participants were taking medication known to affect BP: two were taking diuretics, two were taking beta blockers, and three were taking ACE inhibitors at the time of the study. Screening SBP tended to be higher in the participants who had the dog present in the second QTQ than those who had the dog present in the first QTQ; diastolic BP was not (see Table 2).

Table 2. Mean screening SBP and DBP of those assigned to have the dog present in the first QTQ and those assigned to have the dog present during the second QTQ.

Blood Pressure	Dog Present	*n*	*M*	*SD*	$t_{(9)}$ (*p*)
Systolic	First QTQ	6	133.5	9.95	–1.507 (0.16)
	Second QTQ	5	141.6	7.30	
Diastolic	First QTQ	6	67.8	9.72	−0.260 (0.8)
	Second QTQ	5	69.4	10.26	

An analysis of variance with repeated measures was used to test the effects of activity, dog, and order on DBP. There was a significant three-way interaction ($F_{(1,9)} = 12.8$, $p = 0.006$). DBP increased from quiet to talking the first time talking occurred; the increase was significantly greater when the dog was not present (Dog in 2nd group) than when the dog was present (Dog in 1st group). DBP did not increase from quiet to talking the second time talking occurred if the dog was present (Dog in 2nd group); it did increase from quiet to talking the second time talking occurred if the dog was not present (Dog in 1st group; see Figure 1).

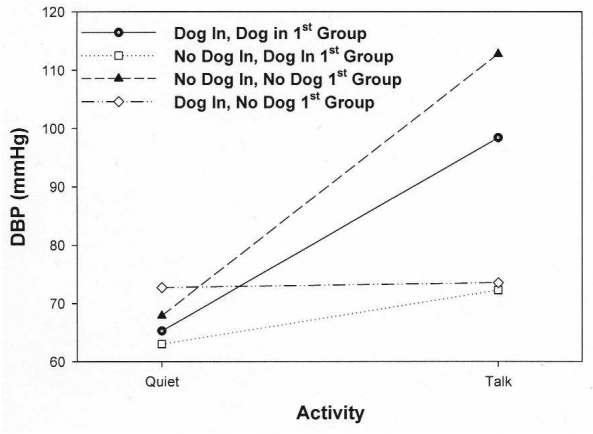

Figure 1. Mean diastolic blood pressure (DBP) of older hypertensives ($n = 11$) while resting silently (quiet) and speaking about their usual daily activities (talk), both with and without a friendly unfamiliar dog present. Mean blood pressures are shown according to whether the dog was present for the first (dog in first group) or the second (dog in second group) half of the experiment.

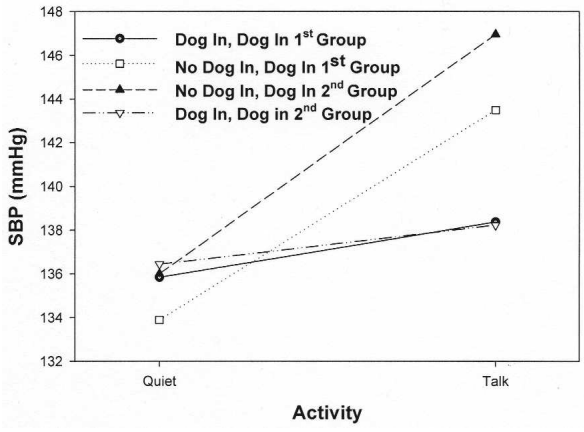

Figure 2. Mean systolic blood pressure (SBP) of older hypertensives ($n = 11$) while resting silently (quiet) and speaking about their usual daily activities (talk), both with and without a friendly unfamiliar dog present. Mean blood pressures are shown according to whether the dog was present for the first (dog in first group) or the second (dog in second group) half of the experiment.

An analysis of covariance with repeated measures was used to test the effects of activity, dog, and order on SBP. Screening SBP was the constant covariate. The means were in the expected pattern and the differences tended toward significance ($F_{(1,8)} = 4.4$, $p = 0.12$). For both groups (Dog in 1st and Dog in 2nd group), after controlling for screening SBP, the increases in SBP from quiet to talking tended to be greater when the dog was not present than when the dog was present (see Figure 2).

Discussion

The results of the study suggest that the presence of a friendly but unfamiliar dog moderated the blood pressure increases in response to stress in older individuals with pre- to mild hypertension, with or without medication. On average, BP was 7/2 mmHg lower when participants spoke with the dog present than when they spoke without the dog present. Blood pressures while sitting silently did not differ according to the presence of the dog.

Even modest reductions in stress responses repeated many times over the course of a day could have significant impact on cardiovascular morbidity and mortality (Gerin et al. 2000; Carroll et al. 2001; Everson et al. 2001). Reductions of 5 mmHg in resting BP are clinically significant, reducing mortality by 9% and strokes by 14% (Chobanian et al. 2003).

A limitation of the current study is that it did not include an assessment of healthy life-styles or behaviors that might also moderate BP or BP responses to stressors. The Joint National Committee on Prevention, Detection, Evaluations and Treatment of High Blood Pressure (JNC) recommends life-style changes as the first strategy for controlling elevated BP (pre-HTN to Stage II HTN) in older adults (Chobanian et al. 2003). Life-style modifications are effective at reducing BP. They include: weight loss, dietary sodium restrictions, and aerobic exercise (MacMahon et al. 1987; Pescatello et al. 1991; Cutler, Follmann and Allender 1997; Seals et al. 1997; Dengel et al. 1998; Tanaka, Reiling and Seals 1998; Fagard 1999; Higashi et al. 1999; Ishikawa et al. 1999; Pescatello et al. 1999; Kokkinos, Narayan and Papademetriou 2001; Sacks et al. 2001; Seals et al. 2001). Relaxation or stress-reduction techniques also can reduce BP and CV mortality (Schneider et al. 1995; Wenneberg et al. 1997; Lee et al. 2003; Barnes, Treiber and Johnson 2004; Schneider et al. 2005).

Most of the participants in the current study were taking medication that affects BP. The reductions in BP responses when the friendly dog was present occurred in addition to reductions in BP due to these medications.

Exercise, diet modification or practice of stress-reduction techniques could provide synergistic effects on the impact of the presence of a friendly animal on CV reactivity. In the current study, three of the 11 participants were recruited from a senior exercise program. Stress-reduction benefits for these individuals from the presence of the friendly dog were above and beyond those from the exercise program. The combined and separate effects of support from animals and life-style modifications should be addressed in future studies.

The current study only examined the moderating effect of the presence of a dog on CV responses in this population. It is likely that other animals also impact CV reactivity in older hypertensives. The animal that will be most effective at moderating stress responses may be different for different individuals. Unusual pets may be effective for specific individuals, for example, Eddy (1996) reports a case study of the impact of a snake on its owner's BP. Dogs are commonly used in experimental studies due to their ease of handling and common acceptance. The standardization of the intervention by using the same unfamiliar dog with all participants, none of whom currently owned a dog, may have under-assessed the moderating influence of an older individual's own pet. The design of the study allowed for equal inclusion of pet owners and non owners. It also prevented the participants' pets from being stressed by being handled by unfamiliar people and the pet owners from being stressed about the need to have their pet behave in a proscribed manner during the study.

The most important limitation of the current study is the small sample size. It is remarkable, though, that an effect of the friendly dog was observed in such a small group. This study needs to be replicated and extended to a more diverse sample of older hypertensives. This study is not

conclusive; it justifies further investigation of the possibility of using pets as an intervention for older adults with BP in the pre-to mild HTN range, both those taking and those not taking medication.

This research is a preliminary step in evaluating a novel intervention for HTN. It has significant implications for policies related to housing and facilities designed for older populations. It also introduces the possibility that the need to initiate or increase medication could be delayed or reduced in the older adult population. Multiple medications with associated side effects and the potential for drug interactions are a common problem for treating multiple morbidities in the older population. Reducing the need for anti-hypertensive medication can improve the availability of treatment options for other conditions.

The present study, coupled with Allen's study of hypertensive men (Allen, Shykoff and Izzo 2001), suggests that pets might provide a viable means of decreasing BP and BP reactivity in older hypertensives. Decreasing stress responses has the potential to decrease morbidity and mortality associated with cardiovascular reactivity. However, the effect of the presence of a pet or friendly animal on cardiovascular status during daily life has not been evaluated. Using ambulatory BP monitoring and multilevel modeling to simultaneously evaluate the contributions of the presence of a friendly animal and factors that contribute to BP on a minute-to-minute basis would provide a more definite answer on the ability of pets to moderate the stress response during normal daily activities.

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