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Momentary social experiences and ambulatory blood pressure levels, reactivity, and nocturnal dipping in Mexican- American women

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Momentary Social Experiences and Ambulatory Blood Pressure Levels, Reactivity, and Nocturnal Dipping in Mexican-American Women

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy

in

Clinical Psychology

by

Adelaide Louise Fortmann

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2013

The Dissertation of Adelaide Louise Fortmann is approved, and it is acceptable in

quality and form for publication on microfilm and electronically:

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2013

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ACKNOWLEDGEMENTS

VITA

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ABSTRACT OF THE DISSERTATION

Momentary Social Experiences and Ambulatory Blood Pressure Levels, Reactivity, and
Nocturnal Dipping in Mexican-American Women

by

Adelaide Louise Fortmann

Doctor of Philosophy in Clinical Psychology

University of California, San Diego, 2013
San Diego State University, 2013

Professor Linda Gallo, Chair

One potential explanation for the predictive utility of ambulatory blood pressure (BP) monitoring is that it captures BP in the context of social experiences that are relevant to cardiovascular health. The interpersonal circumplex (IPC) is a central component of interpersonal theory that categorizes social experiences along two perpendicular axes: affiliation (friendliness vs. hostility) and control (dominance vs.

submissiveness). The present study investigated associations of social interactions and interaction quality with acute ambulatory BP reactivity, mean daytime and nighttime BP, and nocturnal BP dipping in healthy, middle-aged Mexican-American women. Participants (N=260) completed a 36-hour ambulatory BP monitoring assessment; momentary psychosocial experiences were captured via electronic diary. Findings revealed that momentary SBP and DBP were an average of 1.55 and 1.52 mmHg higher (respectively, ps < .001) in the context of a current/recent social interaction relative to observations that did not involve a social interaction. For every additional ~13 social interactions (of any kind), SBP and DBP dipping increased by 0.8% and 1.1%, respectively (ps < .05). For interaction quality, momentary SBP and DBP were an average of 1.31 and 1.00 mmHg higher (respectively, ps < .001) during supportive (i.e., high affiliation) compared to other types of interactions; however, this association was only statistically significant when family member and/or friend was the interaction partner. A cumulative increase of ~9 supportive interactions was associated with a 2.03 mmHg decrease in mean daytime SBP, and 2.20 and 1.28 mmHg decreases in mean nighttime SBP and DBP, respectively (ps < .05). A decrease of ~3 disagreements (i.e., low affiliation) was associated with 1.48 and 1.14 mmHg reductions in mean nighttime SBP and DBP, respectively (ps < .05). Trends were also observed for support and disagreements and greater/lesser nocturnal (DBP) dipping, respectively (ps <.10). No statistically significant associations were observed for ambulatory BP and social experiences characterized by high/low control. This study highlights aspects of the social environment as factors that may shape resilience (via greater interaction frequency, higher levels of support) and risk (via lower interaction frequency, higher levels of

conflict), and thus represent potentially modifiable targets for CVD prevention and

management efforts in Latinos.

Chapter 1: Introduction

Momentary Social Experiences and Ambulatory Blood Pressure Levels, Reactivity,

and Nocturnal Dipping in Mexican-American Women

Latino and *Hispanic* (heretofore "Latino") are terms interchangeably used to refer to individuals of "Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race" (US Census Bureau, 2001). In the US, Latinos represent the largest and fastest growing ethnic minority group (Passel & Cohn, 2008; Pew Hispanic Center, 2011). On the whole, this group experiences disproportionately high rates of various adverse social circumstances [e.g., low socioeconomic status (SES), poor healthcare access, exposure to acculturation and discrimination stress], yet generally exhibits lower rates of mortality and some types of morbidity than their non-Latino White counterparts (Arias, Eschbach, Schauman, Backlund, & Sorlie, 2010; Markides & Eschbach, 2005; Palloni & Arias, 2004). For example, despite the aforementioned (and other) risk factors and barriers to optimal health, Latinos exhibit a lower prevalence of cardiovascular disease (CVD; e.g., hypertension, stroke, coronary heart disease) than non-Latino Whites (Roger et al., 2012). This phenomenon could represent the presence of a health-protective buffer (e.g., culturally-driven behavioral and/or psychosocial processes) against adversity, at least in some Latino subgroups. Few attempts have been made to disentangle the specific source(s) of resilience in this population (Franzini, Ribble, & Keddie, 2001; Markides & Eschbach, 2005; Markides & Eschbach, 2011); however, the social environment represents one potentially important, health-protective resource given the value of personal relationships and family in this culture (Gallo, Penedo, Espinosa de los

Monteros, & Arguelles, 2009; Sanchez-Burks, Nisbett, & Ybarra, 2000). The current study begins to address these issues by exploring the associations of social experiences, assessed in everyday life using an ecological momentary assessment (EMA) paradigm, with ambulatory blood pressure (BP) reactivity, average levels, and nocturnal dipping in middle-aged, Mexican-American women.

Ambulatory Blood Pressure Monitoring

Ambulatory BP monitoring involves the assessment of cardiovascular activity under naturalistic conditions, generally over a period of 24 hours or more, using lightweight, noninvasive, automated devices. Ambulatory assessment provides many advantages over clinic or resting BP measurements; it is indicated for ruling out white coat hypertension (i.e., [artificial] elevations attributable to the clinic setting), screening for masked hypertension (i.e., ambulatory, but not clinic BP values in the diagnosable hypertension range), diagnosing borderline hypertension, identifying nocturnal hypertension, and evaluating response to anti-hypertensive treatments (O'Brien et al., 2000). Research has also shown daytime, nighttime, and 24-hr (plus) ambulatory BP averages to have better reliability than clinic BP assessments(Campbell, Ghuman, Wakefield, Wolfson, & White, 2010) , with reproducibility estimates increasing progressively with the number of ambulatory measurements and peaking at 24 readings (Trazzi et al., 1991).

A review of outcome studies conducted in patients with treated and untreated hypertension found strong evidence for the clinical usefulness of ambulatory BP in refining cardiovascular risk stratification (Verdecchia, 2000). Higher ambulatory BP has also been linked to impairments in left and right ventricular structure, and diastolic

function (Ivanovic, Tadic, & Celic, 2011), with some research reporting stronger relationships between target organ damage (i.e., left ventricular hypertrophy) and ambulatory BP compared to clinic values (Verdecchia, Clement, Fagard, Palatini, & Parati, 1999). Indeed, a growing body of evidence indicates that ambulatory BP measures are better predictors of CVD outcomes than clinic assessments (Dolan et al., 2005; Pickering, Shimbo, & Haas, 2006; Sega et al., 2005). Despite the prognostic value of ambulatory BP, research using these techniques in Latinos is lacking.

Concurrent Momentary Sampling of Daily Experiences and Blood Pressure

One potential explanation for the relative utility of ambulatory monitoring over resting measures is that the former assesses BP in the context of daily experiences that are relevant to cardiovascular health but that may not be reflected in clinic BP readings (Kamarck et al., 2002; Schoenthaler, Schwartz, Cassells, Tobin, & Brondolo, 2010). Daily experiences can be captured using EMA, which involves the repeated sampling of individuals' momentary states in their natural environments (Shiffman, Stone, & Hufford, 2008; Stone & Shiffman, 1994). This technique requires a participant to report what he/she is doing or how he/she is feeling at the *present* moment (via electronic or paper diary), and thus provides a "snap shot" of daily experiences. Ecological momentary assessment improves the ecological validity of measurement, and circumvents several limitations inherent to retrospective self-reporting, including memory distortion and the effects of participants' current state on recall (Kamarck, Shiffman, & Wethington, 2011; Shiffman et al., 2008). In fact, EMA measures have outperformed retrospective self-report assessments of the same psychosocial constructs (i.e., perceived task demand, social integration) in predicting objective health indicators (Kamarck et al., 2004; Troxel

et al., 2010). These techniques can be used in conjunction with ambulatory BP monitoring to explore the role of daily experiences in CVD risk.

Momentary Experiences and Ambulatory Blood Pressure Reactivity: Within-Person Effects

The nested structure (i.e., repeated measures within individuals) of both EMA and ambulatory BP data provides many options for analysis. First, the longitudinal nature of EMA data can be used to examine temporal sequences of momentary experiences, or to document antecedents and consequences of experiences (Shiffman et al., 2008). When used concurrent with ambulatory BP monitoring, EMA can be used to identify correlates of acute BP fluctuations (i.e., "within-person effects") in the natural environment. Causal models of psychophysiological reactivity have in turn connected exaggerated cardiovascular responses (e.g., to psychosocial challenges) with cardiovascular pathology (Lovallo & Gerin, 2003; Schwartz et al., 2003), and several longitudinal studies (e.g., Carroll, Ring, Hunt, Ford, & Macintyre, 2003; Jennings et al., 2004; Treiber et al., 2003) have confirmed these links (i.e., with subsequent hypertension and other CVD outcomes). Experimental research with animal models has more directly examined cardiovascular reactivity as a pathway to disease, and has identified alterations in sympathoadrenal activation as mechanisms connecting psychosocial stimuli with CVD risk (Manuck, Kaplan, Muldoon, & Adams, 1991). Nonetheless, no study to-date has investigated the associations of daily experiences with acute ambulatory BP reactivity in Latinos.

Cumulative Daily Experiences and Ambulatory Blood Pressure: Between-Person Effects

Ecological momentary assessment data can also be aggregated to obtain a measure of the participant across time (Shiffman et al., 2008), which can then be used to predict between-person differences in ambulatory BP levels – e.g., daytime, nighttime, 24-hour (plus) averages – all of which have demonstrated consistent links with CVD (for a review see Pickering et al., 2006). Notably, research has shown mean daytime systolic blood pressure (SBP) to partially mediate the association between aggregate EMA measures of psychosocial demands (averaged across two, three-day sampling periods) and subclinical CVD, as represented by carotid artery intima-medial thickness (Kamarck et al., 2004). Cumulative daily experiences can also be explored as correlates of nocturnal BP dipping, or the relative decline in nighttime relative to daytime BP levels (O'Brien, Sheridan, & O'Malley, 1988). Blunted dipping (i.e., <10%) is consistently associated with target organ damage (Cuspidi et al., 2001), and CVD events and mortality (Fagard et al., 2009; Liu et al., 2003). In fact, several (though not all; e.g., Tsioufis et al., 2011) studies have shown nocturnal BP dipping to be a better predictor of CVD risk and outcomes than average BP levels (Fagard, Thijs et al., 2008; Ohkubo et al., 2002; Staessen et al., 1999). Despite the demonstrated relevance of BP dipping to CVD, few investigations have studied this indicator in Latinos (Brondolo et al., 2008; Hyman, Ogbonnaya, Taylor, Ho, & Pavlik, 2000). The need for more research in this population is clear. Moreover, the simultaneous use of EMA with ambulatory BP monitoring in Latinos may help identify potentially modifiable factors in the social environment that contribute to the

(paradoxical) resilience exhibited by this population, and/or represent valuable targets for CVD prevention and management efforts.

Social Environment and Cardiovascular Disease

Several aspects of the social environment have been identified as important correlates of cardiovascular health. At the most basic level, research has consistently shown social interaction to have protective effects on health. For instance, social integration has related negatively to ischemic heart disease (Barefoot, Gronbaek, Jensen, Schnohr, & Prescott, 2005) and stroke morbidity (Rutledge et al., 2008), and positively to prognosis following myocardial infarction in previous research (Case, Moss, Case, McDermott, & Eberly, 1992). Research utilizing EMA has reported consistent, momentary increases in ambulatory SBP and diastolic blood pressure (DBP) during periods of not interacting versus not (e.g., Brondolo, Karlin, Alexander, Bobrow, & Schwartz, 1999; Brondolo et al., 2003; Guyll & Contrada, 1998); however, greater social contact frequency, assessed via EMA over a 48-hour period, has predicted reduced CVD risk (i.e., greater nocturnal BP dipping; Troxel et al., 2010).

The social environment may be an especially important source of resiliency for Latinos, given the purported cultural value placed on personal relationships and family in this group (i.e., familismo, simpatía; Gallo et al., 2009; Sanchez-Burks et al., 2000). Conversely, daily social experiences may also represent a source of risk in Latinos, given the potential for minority groups to encounter unique kinds of unfair treatment (e.g., racism or discrimination), and the observed effects of perceived racism and discrimination on cardiovascular health (Brondolo, Love, Pencille, Schoenthaler, & Ogedegbe, 2011; Pascoe & Smart Richman, 2009). Thus in addition to the mere

frequency of social interactions, specific *qualities* of interactions may have important implications for health.

Theoretical frameworks, such as the interpersonal model (Horowitz, 2004; Kiesler, 1996; Pincus & Ansell, 2003), are useful in categorizing qualitative aspects of interactions. A key component of the interpersonal model, the *interpersonal circumplex* (IPC; see Figure 1; Kiesler, 1983) classifies social stimuli and responses, and more stable features of individuals' behavior and social environments, along two perpendicular axes: affiliation and control. The affiliation axis is anchored by hostility (cold, quarrelsome) and friendliness (warm, agreeable), while control contrasts dominance (ambitious, dominant) with submissiveness (lazy, submissive). The two traits from the Five-Factor Model of personality (Digman, 1990) that are most relevant to social behavior, extraversion/introversion and agreeableness/antagonism, are rotational equivalents of the IPC affiliation and control axes. The *transactional cycle* posits that through both covert and overt actions, individuals influence the social behaviors of others in ways that are consistent with the initial actor's personality (see Figure 2; Carson, 1969; Kiesler, 1996). This influence involves correspondence on the IPC affiliation axis (e.g., friendly personalities may evoke support and warmth from others), and reciprocity on the IPC control axis (e.g., dominant personalities generally evoke submissive reactions from others). Thus, the transactional cycle provides a framework for understanding connections between personality and social behavior (Smith, Gallo, Shivpuri, & Brewer, 2011). In addition, prior research has shown that these models provide a useful framework for capturing interpersonal aspects of personality across cultures, including in Latinos (McCrae & Terracciano, 2005; Ortiz et al., 2006).
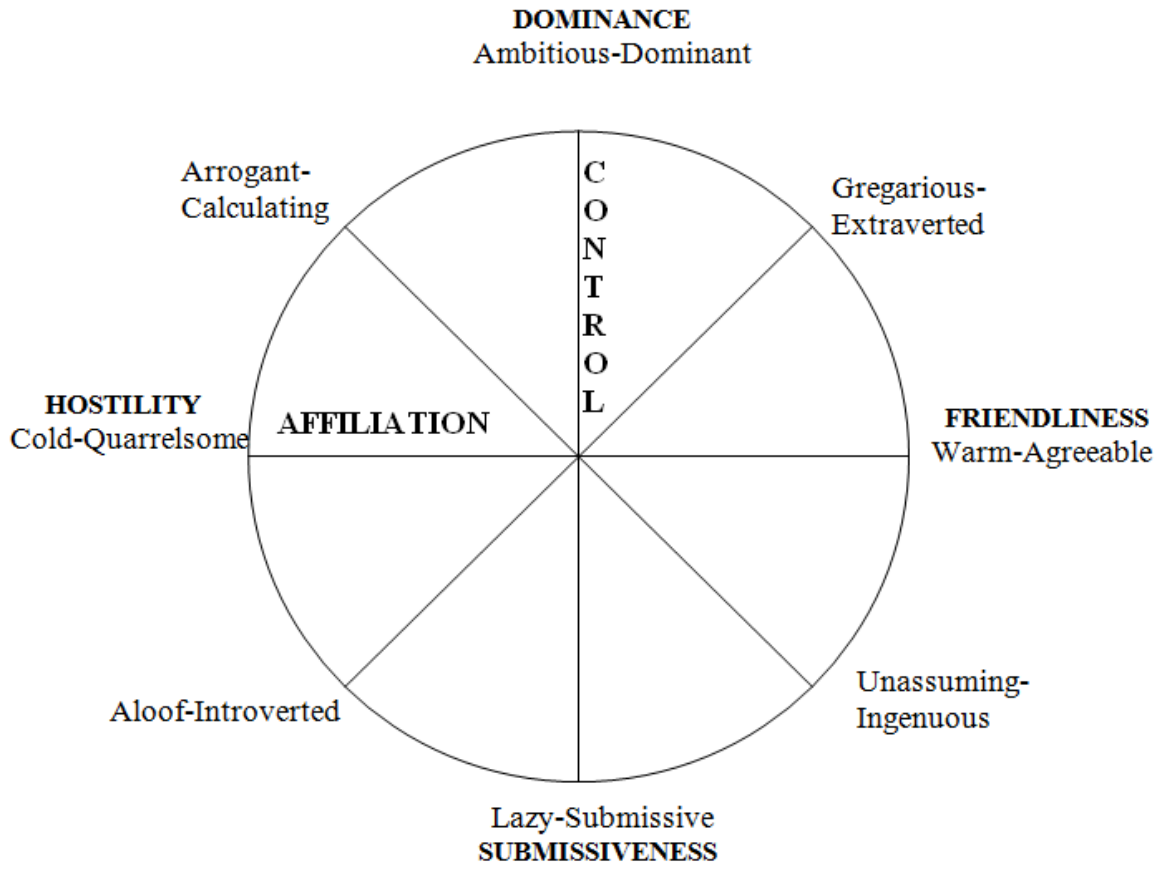
Figure 1. The interpersonal circumplex. Source: Gallo, L. C., & Smith, T. W. (1999). Patterns of hostility and social support: Conceptualizing psychosocial risk factors as characteristics of the person and the environment. *Journal of Research in Personality, 33*, 281-310.

Several studies have investigated associations of interactions characterized by high/low affiliation and high/low control with cardiovascular health. The vast majority of research that has been conducted to-date has reported protective effects of social support (i.e., high affiliation), variously defined, on CVD risk and outcomes (for reviews see, Barth, Schneider, & von Kanel, 2010; Low, Thurston, & Matthews, 2010; Shaya et al., 2010). Conversely, social environments characterized by relatively lower levels of affiliation have predicted poorer health outcomes. For instance, two recent syntheses of the literature reported consistent, positive associations of perceived discrimination

INDIVIDUAL

COVERT EXPERIENCE

BELIEFS
LIFE TASKS
GOALS
SCRIPTS
SELF AND OTHER SCHEMA
APPRAISALS
AFFECT

OVERT BEHAVIOR

SITUATION CHOICE
SELF-PRESENTATION
TACTICS
EMOTION

COVERT EXPERIENCE

CONSTRICTED
APPRAISAL
ATTRIBUTION
AFFECT
ACTION TENDENCIES

OVERT REACTIONS

CONSTRICTED
COMPLEMENTARY RESPONSES

OTHERS IN THE SOCIAL ENVIRONMENT
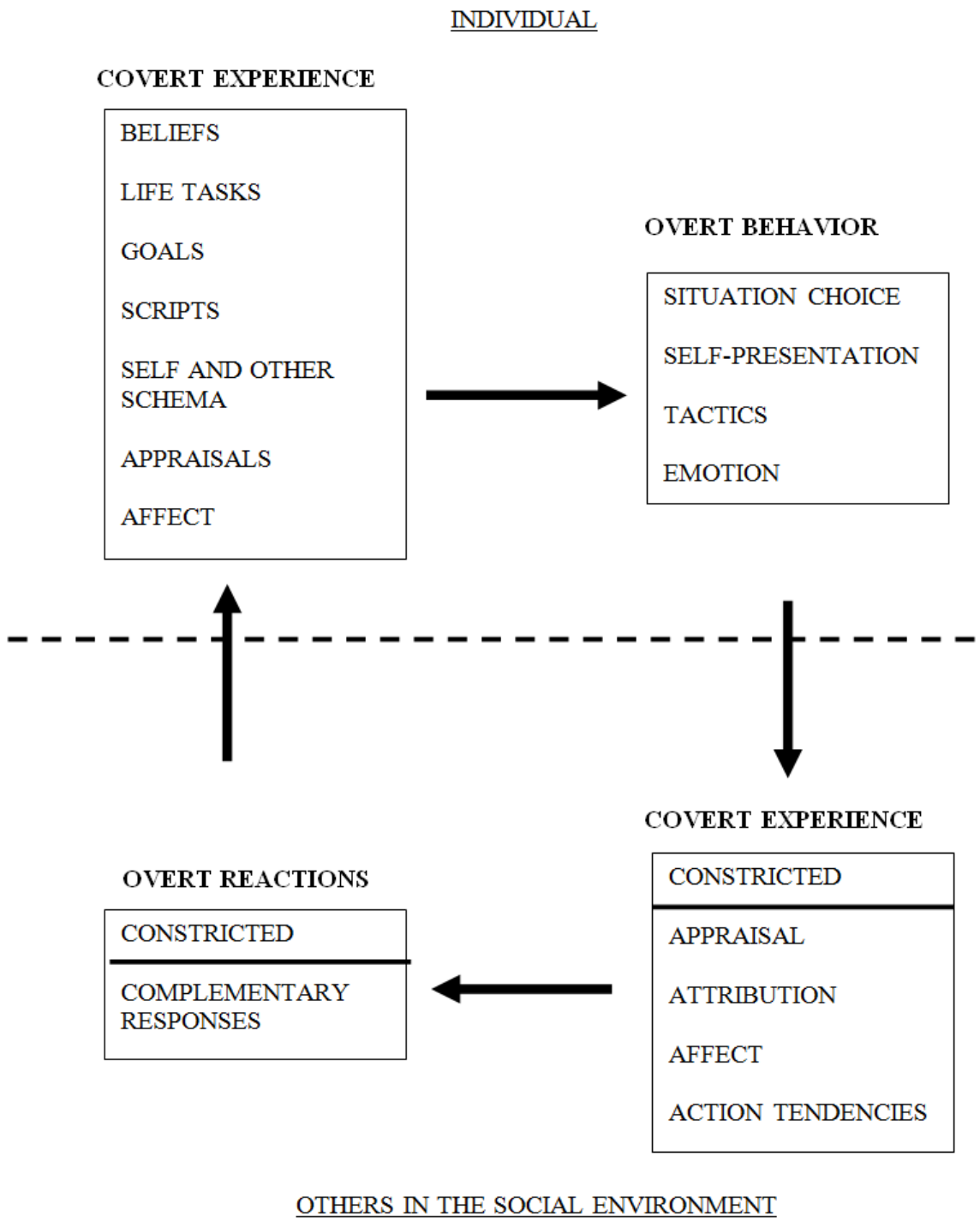
Figure 2. The transactional cycle. Adapted from: Kiesler, D. J. (1996). *Contemporary interpersonal theory and research: Personality, psychopathology, and psychotherapy.* New York, NY: John Wiley & Sons.

(Pascoe & Smart Richman, 2009) and racism (Brondolo et al., 2011) with CVD risk indicators and outcomes, including ambulatory BP. A review on the role of control in CVD (Newton, 2009) found that trait dominance (i.e., high control) was positively associated with CVD severity, incidence, and progression; preliminary evidence from two reviewed studies suggested that trait submissiveness (i.e., low control) may be health-protective.

These and other reported associations between cumulative levels of high/low affiliation/control in the social environment (assessed via global, retrospective self-report measures) and CVD may be due, in part, to the influence of the former on daily experiences. In fact, momentary assessments may be more relevant than global measures to understanding the role of interaction quality in health (Kamarck et al., 2004; Troxel et al., 2010). The research reviewed below implemented ecological sampling to examine momentary social experiences characterized by low/high affiliation and control as predictors of acute BP reactivity (i.e., within-person effects) and/or chronic alterations in BP (i.e., between-person effects).

Affiliation   Social interactions characterized by low affiliation have demonstrated associations with ambulatory BP in prior research. For instance, Brondolo et al., (1999) and Karlin, Brondolo, and Schwartz (2003) found SBP and DBP to be higher during (or within ten minutes of) a social conflict relative to daily experiences that did not involve conflict. Cumulative levels of interpersonal conflict, assessed via EMA over the course of six days, also predicted significantly higher (6-day) mean SBP in the same healthy adult sample (Kamarck et al., 2002). Momentary perceptions of being treated unfairly or harassed over a 24-hour ecological assessment period also predicted masked hypertension status assessment (Schoenthaler et al., 2010). In the only EMA study to directly investigate associations of affiliative social experiences with ambulatory BP, the main effects of supportive and intimate social interactions were not reported as they were significantly moderated by trait hostility (Vella, Kamarck, & Shiffman, 2008). However, research using global, retrospective measures of affiliation has shown significant inverse associations of perceived social support (Karlin et al., 2003; Piferi & Lawler, 2006) and relationship quality (Grewen, Girdler, & Light, 2005) with mean ambulatory BP, and positive associations between perceived availability of social support and nocturnal BP dipping (e.g., Rodriguez et al., 2008; Spruill et al., 2009). In addition, a self-report measure of support provision related significantly to lower mean ambulatory BP (Piferi & Lawler, 2006).

Control   No study to our knowledge has investigated momentary perceptions of control (via EMA) and ambulatory BP associations solely in the context of social interactions. Existing research has shown positive associations between self-report measures of trait dominance (i.e., high control) and BP reactivity during dyadic interactions; however, findings have been observed more consistently in men than women (e.g., Newton, Bane, Flores, & Greenfield, 1999; Newton, Watters, Philhower, & Weigel, 2005). Other studies have shown ambulatory DBP to be higher during instances of low versus high decisional control (not specific to social interactions; Bishop et al., 2003; Kamarck et al., 2002; Kamarck et al., 1998). Notably, in Kamarck et al. (2002), the effect magnitude was smaller for decisional control than for social conflict (reported above), indicating relatively less reactivity associated with general daily experiences characterized by high control compared to social experiences characterized by low affiliation (β = -0.09 vs. 0.41). Cumulative decisional control has also been linked to between-person differences in mean daytime DBP (Bishop et al., 2003), and in (6-day) mean SBP and DBP (Kamarck et al., 2002), with greater perceived control over time relating to lower BP in both studies.

Moderation by Interaction Partner Observational studies using EMA to track social experiences in the natural environment have reported reduced BP reactivity during interactions with familiar individuals. For instance, in a sample of healthy, African-American and White adults, ambulatory BP was significantly lower during social interactions with one's partner compared to interactions with any other person; partner effects were not mediated by emotional activation, intimacy, or perceived emotional support (Gump, Polk, Kamarck, & Shiffman, 2001). In another study, ambulatory BP was lowest among college students while interacting with family members and spouses, and highest during interactions with less familiar network members (Holt-Lunstad, Uchino, Smith, Olson-Cerny, & Nealey-Moore, 2003). Holt-Lunstad et al. (2003) examined momentary ratings of positive affect, negative affect, self-disclosure, and intimacy as potential mediators of interaction partner effects on BP reactivity; however, all indirect effects were again non-significant. Although the above studies did not identify significant mechanism(s) underlying the observed interaction partner effects, alternative explanations have been proposed. For instance, experimental research conducted in both the laboratory (e.g., Phillips, Gallagher, & Carroll, 2009) and the field (e.g., Phillips, Carroll, Hunt, & Der, 2006) suggests that the presence of a spouse and/or friend(s) attenuates cardiovascular reactivity during stressor exposure (though effects have exhibited significant variability by gender and other factors).

Summary   These findings provide preliminary evidence that, in general, ambulatory BP increases during social interactions. When stratified by interaction quality, however, momentary social experiences at opposing ends of the IPC affiliation (i.e., "hostility" versus "friendliness") and control (i.e,. "submissiveness" versus "dominance") axes appear to have differential associations with ambulatory BP (positive and negative, respectively for each axis). Further, some studies have reported significant variability in these relationships across interaction partner.

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Current Aims

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Despite the observed links between social experiences and ambulatory BP, and the utility of ambulatory BP in predicting CVD, research in this area is lacking among Latinos. One of the two studies to our knowledge to examine psychosocial factors and ambulatory BP in Latinos reported an inverse association between a retrospective, self-report measure of racism and nocturnal BP dipping (Brondolo et al., 2008). However, this investigation was conducted in a multi-ethnic sample and did not utilize EMA to capture *momentary* social experiences. The second study to examine psychosocial factors and ambulatory BP in Latinos to-date (Schoenthaler et al., 2010, presented above) implemented EMA, but also presented findings for a combined sample of Latino and non-Latino Black participants. More research with specific Latino subgroups is needed, especially given the reported variance in the strength and direction of relationships between social experiences and ambulatory BP across other racial/ethnic groups that have been studied more intensively (e.g., Cooper, Ziegler, Nelesen, & Dimsdale, 2009; Troxel et al., 2010). The present study begins to address the aforementioned gaps in the literature by investigating associations of social interactions (Specific Aims 1 and 2) and

interaction quality (classified according to the IPC affiliation and control axes; Specific Aims 3 and 4) with acute ambulatory BP reactivity, mean daytime and nighttime BP, and nocturnal BP dipping in a well-defined, relatively homogeneous Latino subgroup: healthy, middle-aged Mexican-American women residing in the US-Mexico border region in Southern San Diego County. More specifically, this study aims to do the following.

Specific Aim 1: Examine the Within-Person Associations of Social Interactions with Ambulatory BP Reactivity

Hypothesis 1: It was hypothesized that ambulatory SBP and DBP would be *higher* when measured in conjunction with current or recent social interactions relative to observations that did not involve a social interaction.

Specific Aim 2: Examine the Between-Person Associations of Social Interactions with Mean Daytime and Nighttime BP, and Nocturnal BP Dipping

Hypothesis 2: It was hypothesized that individuals reporting a greater number of social experiences would exhibit *lower* mean daytime and nighttime SBP and DBP, and *higher* nocturnal SBP and DBP dipping percentages compared with individuals reporting relatively fewer interactions.

Specific Aim 3: Examine Within-Person Associations of Interaction Quality (i.e., High/Low Affiliation and High/Low Control) with Acute BP Reactivity

Hypothesis 3.1: It was hypothesized that ambulatory SBP and DBP would be *lower* when measured in conjunction with current or recent *high affiliation* social interactions (i.e., [i] receiving or [ii] giving support] relative to observations that did not involve receiving or giving support (respectively).

Hypothesis 3.2: It was hypothesized that ambulatory SBP and DBP would be *higher* when measured in conjunction with current or recent *low affiliation* social interactions (i.e., [i] having a conflict/disagreement, or [ii] being treated unfairly) relative to observations that did not involve having a conflict/disagreement or being treatment unfairly (respectively).

Hypothesis 3.3: It was hypothesized that ambulatory SBP and DBP would be *lower* when measured in conjunction with current or recent *high control* social interactions (i.e., feeling "in charge") relative to observations in which participants did not report feeling "in charge."

Hypothesis 3.4: It was hypothesized that ambulatory SBP and DBP would be *higher* when measured in conjunction with current or recent *low control* social interactions (i.e., feeling "bossed around") relative to observations in which participants did not report feeling "bossed around."

Specific Aim 4: Examine Between-Person Associations of Interaction Quality (i.e., High/Low Affiliation and High/Low Control) with Average Daytime and Nighttime BP, and Nocturnal BP Dipping

Hypothesis 4.1: It was hypothesized that individuals reporting a greater number of *high affiliation* social experiences (i.e., [i] giving support, [ii] receiving support) would exhibit *lower* mean daytime and nighttime SBP and DBP, and *higher* nocturnal SBP and DBP dipping percentages compared with individuals reporting relatively fewer interactions involving giving or receiving support (respectively).

Hypothesis 4.2: It was hypothesized that individuals reporting a greater number of *low affiliation* social experiences (i.e., [i] having a conflict/disagreement, [ii] being

treated unfairly) would exhibit *higher* mean daytime and nighttime SBP and DBP, and *lower* nocturnal SBP and DBP dipping percentages compared with individuals reporting relatively fewer interactions involving a disagreement or unfair treatment (respectively).

Hypothesis 4.3: It was hypothesized that individuals reporting a greater number of *high control* social experiences (i.e., feeling "in charge") would exhibit *lower* mean daytime and nighttime SBP and DBP, and *higher* nocturnal SBP and DBP dipping percentages compared with individuals reporting relatively fewer interactions in which they felt "in charge."

Hypothesis 4.4: It was hypothesized that individuals reporting a greater number of *low control* social experiences (i.e., feeling "bossed around") would exhibit *higher* mean daytime and nighttime SBP and DBP, and *lower* nocturnal SBP and DBP dipping percentages compared with individuals reporting relatively fewer interactions in which they felt "bossed around."

Exploratory Aim: Evaluate Family/Friend Presence during Social Interactions as a Moderator of Interaction Quality-Ambulatory BP Associations

Hypothesis E1: It was hypothesized that the presence of family and/or friend(s) during a social interaction would significantly moderate associations of interaction quality (i.e., high/low affiliation and high/low control) with ambulatory BP fluctuations (Specific Aim 2), such that acute increases in BP would be relatively *smaller* in magnitude with *family and/or friends* present (versus strangers, acquaintances, or coworkers).

Hypothesis E2: It was hypothesized that family and/or friend presence would significantly moderate associations of interaction quality (i.e., high/low affiliation and

high/low control) with summary BP measures (mean daytime and nighttime BP,
nocturnal BP dipping; Specific Aim 4), such that these associations would be relatively
smaller in magnitude as the number of interactions involving *family and/or friends*
increased.

Chapter 2: Methods

Data were collected as part of a larger investigation of cardiovascular risk in healthy, middle-aged Mexican-American women residing near the US-Mexico border in San Diego, CA ("Nuestra Salud" or "Our Health"). A commercial database (Haines and Company, North Canton, OH) was used to generate a list of households with a Latino female resident in the target age range. Telephone and mail procedures were then used to randomly select and recruit participants from this list. To be eligible for enrollment in the parent study, women needed to be Mexican-American, 40-65 years of age, literate, and free of physician-diagnosed major health conditions (e.g., CVD, diabetes, liver and kidney diseases, chronic inflammatory conditions, etc.) and medications with known autonomic effects (e.g., stimulants, steroids, major tranquilizers). A total of 656 women were screened according to the above criteria. Of these, 363 (55.3%) were eligible, 321 (88.4% of eligible women) agreed to participate, and 301 completed sociodemographic and psychosocial questionnaires and ambulatory BP monitoring.

Procedures

Clinical and survey assessments were conducted by trained, bilingual research technicians over the course of two weekday home visits. During the first visit, participants completed self-report measures in their preferred language (Spanish or English) assessing sociodemographic characteristics, psychosocial factors, and health behaviors. The second visit included a fasting blood draw and anthropometric assessment (resting BP, height, weight, waist circumference). Participants were instructed to avoid strenuous exercise and alcohol consumption for at least 24 hours, and to avoid consuming caffeine and tobacco for at least 30 minutes prior to the physical exam. Lastly,

participants completed a 36-hour ambulatory BP monitoring assessment; momentary

psychosocial experiences were captured during daytime hours via electronic diary. The

San Diego State University and the University of California San Diego Institutional

Review Boards approved study procedures and all participants provided written informed

consent.

Measures

Ambulatory Blood Pressure

Ambulatory BP was assessed over two consecutive days during a typical work

week with small noninvasive devices (Spacelabs Model 90217-1Q; Spacelabs, Inc, Tulsa,

OK) utilizing oscillometric detection methods that have been shown to meet standards for

accuracy and reliability set forth by the Association for the Advancement of Medical

Instrumentation (Baumgart & Kamp, 1998). Women were fitted with the monitor and

instructed to wear it for a total of 36 hours, removing it only to shower and dress. The

monitors recorded SBP and DBP once every 30 minutes during the day and every 60

minutes during sleeping hours (according to participant-reported sleep and wake times),

in dynamic inflation mode, and with 1 retry for erroneous readings. Participants were

blinded to their readings throughout the assessment period.

Prior to analysis, ambulatory BP data were screened and cleaned consistent with

criteria outlined by Marler, Jacob, Lehoczky, and Shapiro (1988). The remaining BP

readings served as level-1 outcome values in within-person analyses, and were also used

to create level-2 summary BP measures for between-person analyses. In regard to the

latter, Hierarchical Linear Modeling (HLM) 6.06 (Scientific Software International,

Lincolnwood, IL) with maximum likelihood estimation was used to compute mean

daytime/nighttime SBP and DBP values for each participant, as this approach accounts for clustered data (i.e., repeated measures within individuals). Nocturnal BP dipping was calculated by dividing each participant's nighttime SBP and DBP means by their respective daytime SBP and DBP means; participant-reported sleep and wake times were used to differentiate nighttime from daytime BP values. These values were then subtracted from 1.0 and multiplied by 100 to reflect percent dipping, with higher values indicating larger nighttime decreases in BP relative to daytime values (i.e., greater "dipping").

Electronic Diary

Participants completed an electronic diary within 10 minutes following each daytime ambulatory BP reading using a Palm handheld computer (Palm, Inc.) programmed with a 31-item survey using Pendragon Forms 5.0 Software (Pendragon Software Corporation, Buffalo Grove, IL). Participants were instructed to answer the diary items by touching the appropriate multiple-choice response on the screen of the handheld device with a stylus. Diary items took an average of two to three minutes to complete in total.

Social interactions. Participants were asked to report whether or not they were interacting with someone at the time of the reading (yes/no), and if not, whether a social interaction occurred since the last reading (yes/no). For within-person analyses, these two items were combined into a single, dichotomous, "social interaction" variable to indicate the current *or* recent occurrence of any kind of social interaction (yes = 1; no = 0). This variable was summed within-person to create a level-2 count variable for between-person analyses (i.e., reflecting total social interaction frequency for each participant).

Interaction quality. When participants responded "yes" to indicate a current or recent social interaction they were then asked to complete six additional "interaction quality" items (see Table 1) assessing the extent to which the interaction was consistent with each IPC dimension (0 = not at all, 1 = somewhat, 2 = a lot). Level-1 interaction quality variables were dichotomized (0 = not at all, 1 = somewhat/a lot) for within-person analyses, and summed within person to create six, level-2, count variables for between-person analyses (i.e., reflecting the total number of each interaction quality endorsed by each participant).

Table 1. Items Assessing Interaction Qualities, According to Each IPC Dimension

IPC dimension	Item(s)
Affiliation	
High/friendly	1. Provided help to others
	2. Others provided help
Low/hostile	3. Had conflict or disagreement
	4. Felt treated unfairly
Control	
High/dominance	5. Felt in charge
Low/submissive	6. Felt bossed around

Note. A 3-point response scale was used for each item (0 = not at all, 1 = somewhat, 2 = a lot)

Interaction partner. For each social interaction, participants were also asked to report with whom they were interacting (i.e., spouse, child, parent, other relative, supervisor, coworker, friend, acquaintance, stranger; all yes/no). For within-person analyses, these items were combined to create a dichotomous, level-1, "family/friend"

variable reflecting the presence (coded 1) versus absence (coded 0) of spouse, family member, or friend during each interaction. For between-person analyses, six, level-2, "family/friend presence" count variables were created to indicate the frequency of family and/or friend presence during each qualitative type of interaction - i.e., received support, provided support, disagreement, unfair treatment, bossed around, and in charge.

Level-1/time-varying covariates. The remaining items were designed to assess a variety of factors that can affect BP at the time of assessment, including posture (lying, sitting, standing), temperature (too cold, comfortable, too hot), activity level (no activity, some movement, moderate, strenuous), food intake (yes/no) and substance use (caffeine, alcohol, nicotine, and "other" drugs or medications; all yes/no; (Carels, Sherwood, & Blumenthal, 1998; Janicki & Kamark, 2008; Kamarck et al., 1998). These variables were dummy-coded (unless originally dichotomous) and entered as time-varying covariates to control for fluctuations in ambulatory BP attributable to these extraneous influences.

Data Matching

Participants were instructed to complete the above diary items each time a BP reading was taken during the day to result in ~56 diary entries (i.e., 2 readings per each of the 28 waking hours during the 36-hour monitoring period). Following data collection, BP and diary data were uploaded from the respective devices, and combined in a single data set for analysis. Each diary entry was matched to a BP reading using the timestamp on both devices. Diary entries completed up to three minutes before (e.g., in the case of BP retries) or 10 minutes after a BP reading were "matched" with the respective BP value for analysis.

Level-2/Person-Level Covariates and other Demographic Variables

Variables related to individual differences in ambulatory BP in prior research

(e.g., Shapiro et al., 1996; Spruill et al., 2009; Stepnowsky, Nelesen, DeJardin, &

Dimsdale, 2004) were included as level-2/person level covariates in HLM: age (in years),

smoking status (current regular smoker, 0 = no, 1 = yes), body mass index (BMI; body

weight [in kg]/height [in m^2]), educational attainment (recoded into six categories for

analysis), and total monthly household income (assessed on an ordinal scale in $500

increments, recoded into six categories for analysis). Analyses also controlled for

language of the survey (i.e., Spanish = 0 and English = 1), as a proxy for acculturation.

Employment status, insurance coverage, and country of origin are also reported in the

current study for sample descriptive purposes.

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Statistical Analyses

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Analyses were performed using PASW Statistics 18.0 (SPSS, Inc., Chicago IL)

and HLM 6.06 (Scientific Software International, Lincolnwood, IL) with maximum

likelihood estimation. Model assumptions regarding linearity, normality, independence,

and homoscedasticity of errors were assessed graphically and analytically. Descriptive

statistics were calculated to describe sample characteristics and study variables.

Statistical significance was defined as $p < .05$; marginally significant findings ($p < .10$)

are also reported due to the incipient status of this research in the Latino population.

Specific and Exploratory Aim-related analyses were conducted as outlined below.

Within-Person Associations of Social Interaction (Specific Aim 1) and Interaction

Quality (Specific Aim 3) with Ambulatory BP Fluctuations

For within-person analyses, HLM was used to regress repeated BP observations

on the level-1, social interaction variable (Specific Aim 1), and on all level-1, interaction quality variables (received support, provided support, disagreement, unfair treatment, in charge, bossed around; Specific Aim 3). The latter were entered simultaneously to examine the contribution of a given interaction quality to momentary BP while controlling for variability on all other indicators, as it was possible for a single interaction to be characterized by multiple qualities. Systolic BP and DBP were examined as individual outcomes in separate models. All within-person analyses controlled for time-varying (posture, temperature, activity level, and food and drug consumption) and person-level covariates (age, smoking status, BMI, education, income, language). Consistent with the approach outlined by Kamarck et al. (2002), covariates were entered as fixed effects, and predictors were modeled as random coefficients so that individual differences in the magnitude of the latter effects could be determined. All level-1 predictors were participant mean-centered (i.e., centered about the mean for a given individual), whereas level-2 predictors and all covariates were grand-mean centered (i.e., centered about the mean for the sample) upon entry to multi-level models. Analyses investigating within-person effects of interaction quality (Specific Aim 3) were limited to observations in which participants reported the current or recent occurrence of a social interaction (i.e., social interaction variable = 1).

For exploratory within-person analyses, the level-1, family/friend variable was multiplied by each level-1, interaction quality variable to create six "family/friend present-by-interaction quality" interaction terms. Analyses proceeded in HLM as outlined for Specific Aim 3, with the addition of this interaction term and the family/friend variable. This process was repeated for each level-1 outcome, SBP and DBP.

Between-Person Associations of Social Interaction (Specific Aim 2) and Interaction

Quality (Specific Aim 4) with Ambulatory BP Summary Measures

SPSS was used to regress each level-2, ambulatory BP outcome variable on the

level-2, social interaction frequency variable (Specific Aim 2), and then on each

interaction quality variable (received support, provided support, disagreement, unfair

treatment, in charge, bossed around - all count variables; Specific Aim 4). In contrast to

within-person analyses, the level-2, interaction quality variables were examined in

separate models because the relative contribution of each interaction quality to

ambulatory BP was not of primary interest. Rather, the goal was to examine how

aggregate exposure to each specific type of interaction quality related to mean daytime

and nighttime BP and dipping. However, between-person investigations of interaction

quality did control for overall social interaction frequency to examine the contributions of

specific interaction qualities to ambulatory BP over and above each participant's overall

level of social contact. All between-person analyses controlled for the person-level

covariates listed above.

For exploratory between-person analyses, each family/friend presence count

variable (reflecting the frequency of family and/or friend presence during each qualitative

type of interaction - i.e., received support, provided support, disagreement, unfair

treatment, bossed around, and in charge) was multiplied by the respective level-2,

interaction quality count variable to create six "family/friend presence-by-interaction

quality" terms. Analyses proceeded in SPSS as outlined for Specific Aims 2 and 4, with

the addition of this interaction term and the family/friend presence count variable. This

process was repeated for each level-2 outcome (mean daytime and nighttime BP and

dipping).

Chapter 3: Results

Descriptive Statistics

Table 2 displays descriptive statistics for all study variables. Of the N = 301

women who completed self-report measures and ambulatory BP monitoring, n = 2 were

excluded because they reported taking medications that can affect BP, n = 1 did not

register any valid BP values, n = 8 had < 3 valid nighttime BP values (for the calculation

of nocturnal BP dipping), n = 28 registered < 50% compliance (i.e., < 28 lines of valid

daytime data that included both a valid BP value and a matched diary entry), and n = 2

reported zero social interactions during the monitoring period. The (total) N = 41 women

who were excluded did not differ significantly from the remaining N = 260 participants

included in the present analyses on any demographic factor (all $ps> .10$). Study

participants ranged in age from 40 to 65 years old (Mean = 49.60 years; SD = 6.48). The

majority were married or living with a partner (75%), born in Mexico (74%), and

indicated Spanish as their preferred language (58%). Sixty five percent of women

reported obtaining at least a high school education, and 60% indicated an annual

household income of $35,000 or greater.

Electronic Diary

The number of (matched) diary entries ranged from 28 to 67 per participant (mean

= 47.58; SD = 7.47). Participants reported between one and 53 current or recent (since

last cuff inflation) social interactions (Mean = 25.69; SD = 13.06). A friend and/or

family member was present during an average of 73.48% (Range 0-100%; SD = 23.18%)

of these social interactions. The most frequently reported interaction quality was

"provided support" (mean occurrences/participant = 14.59; SD = 9.95); "unfair

Table 2. Descriptive Statistics for Sociodemographic, Electronic Diary, and Physiological Variables

	N (%)		M (SD)
English as preferred language	110 (42.3)	Electronic Diary Variables[1]	
Born in the United States	67 (25.8)	Total number of diary entries[2]	47.58 (7.47)
Married or cohabitating	195 (75.0)	Total number of social interactions	25.69 (13.06)
Educational Attainment		Interaction Quality	
<9th grade	43 (16.5)	Affiliation	
Some high school (no diploma)	47 (18.1)	Received support	11.78 (9.46)
High school degree or equivalent	32 (12.3)	Provided support	14.59 (9.95)
Some college	82 (31.5)	Disagreement	3.16 (3.44)
Bachelor's degree	41 (15.8)	Unfair treatment	0.80 (1.44)
Graduate level degree	15 (5.8)	Control	
Yearly Household Income		In charge	17.87 (12.80)
<$15,000	25 (9.6)	Bossed around	2.70 (3.94)

(table continues)

Table 2. Descriptive Statistics for Sociodemographic, Electronic Diary, and Physiological Variables, Continued

$15,000 – 24,999	38 (14.6)	**Ambulatory Blood Pressure**
$25,000 – 34,999	42 (16.2)	Number of valid daytime values[3]	53.29 (5.53)
$35,000 – 49,999	49 (18.8)	Number of valid nighttime values	7.10 (1.69)
$50,000 – 74,999	50 (19.2)	Daytime SBP (mmHg)	118.63 (11.28)
≥$75,000	56 (21.5)	Daytime DBP (mmHg)	74.18 (6.74)
Employed for wages (by self or other)	167 (64.2)	Nighttime SBP (mmHg)	102.97 (10.90)
Health insurance coverage	183 (70.4)	Nighttime DBP (mmHg)	62.40 (6.30)
Smoker	25 (9.6)	SBP nighttime dipping (%)	13.08 (5.95)
Body mass index[4]	28.87 (6.26)	DBP nighttime dipping (%)	15.69 (6.68)

Total N = 260.
[1]Values represent within-person counts.
[2]Only diary entries that were matched with valid daytime BP values were included.
[3]Daytime BP means were calculated using all valid daytime BP readings (i.e., including those without a matched diary entry).
[4]Body mass index = weight in kg/height in m2.

treatment" was endorsed least often (mean occurrences/participant = 0.80; SD = 1.44).

Within- and between-person correlations among all interaction quality variables are

presented in Table 3. At the within-person level, statistically significant, small-to-

medium associations were observed for receiving support with providing support ($r =$

0.29, $p < .001$) and feeling in charge ($r = 0.13$, $p < .001$); providing support and feeling in

charge were also correlated ($r = 0.27$, $p < .001$). Having a disagreement covaried with

reports of unfair treatment ($r = 0.31$, $p < .001$) and feeling bossed around ($r = 0.39$, $p <$

.001); the latter two interaction qualities were also correlated ($r = 0.29$, $p < .001$). At the

between-person level, bivariate correlations among all interaction quality (count)

variables were positive and statistically significant, ranging from $r = 0.22$ ("treated

unfairly" and "felt in charge") to $r = 0.85$ ("provided support" and "received support")

(all ps $< .001$; see Table 3).

Between-person associations of demographic factors with interaction quality

variables controlled for overall social interaction frequency. Women who were relatively

more acculturated [as indicated by English (versus Spanish) as preferred language]

reported giving ($r = 0.29$, $p < .001$) and receiving support more often ($r = 0.18$, $p < .01$),

fewer interactions in which they felt bossed around ($r = -0.36$, $p < .001$), and a greater

number of interactions in which they felt in charge ($r = 0.23$, $p < .001$). Women who

were older in age reported receiving support more often ($r = 0.13$, $p = .04$) than younger

participants. Higher educational attainment and yearly household income (respectively)

predicted a higher number of interactions that involved support provision (rs $= 0.28$ and

0.14, ps $< .05$) and feeling "in charge" (rs $= 0.26$ and 0.15, ps $< .05$). In addition, higher

education (but not income) predicted greater received support ($r = 0.20$, $p < .01$), whereas

Table 3. Within- and Between-Person Associations among Social Interaction and Interaction Quality Variables

Variable	1	2	3	4	5
1. Received support					
2. Provided support	0.29** / 0.85**				
3. Disagreement	0.01 / 0.50**	0.06** / 0.53**			
4. Treated unfairly	-0.01 / 0.28**	0.01 / 0.24**	0.31** / 0.54**		
5. In charge	0.13** / 0.69**	0.27** / 0.80**	0.04* / 0.46**	-0.01 / 0.22**	
6. Bossed around	0.02§ / 0.32**	0.07** / 0.29**	0.39** / 0.52**	0.29** / 0.43**	0.09** / 0.32**

Note. ** $p < .001$. * $p < .05$ and § $p < .10$. Values represent within-person/between-person bivariate correlations.

higher household income (but not education) was associated with fewer interactions in which participants felt bossed around ($r = -0.24$, $p < .001$).

Ambulatory Blood Pressure

Mean daytime and nighttime BP (presented in Table 2) were calculated based on an average of 53.29 (SD = 5.53) and 7.10 (SD = 1.69) valid readings per person, respectively. Average nocturnal BP dipping ranged from -8.99% (i.e., higher mean nighttime versus daytime BP) to 29.62% for SBP (Mean = 13.08%, SD = 5.95) and from -5.92% to 29.97% for DBP (Mean = 15.69%, SD = 6.68%). Approximately 28% (n = 72) and 18% (n = 47) of participants exhibited a non-dipping pattern (i.e., <10% nocturnal decrease) in SBP and DBP, respectively.

<div align="center">

Social Experiences and Ambulatory Blood Pressure

</div>

Table 4 displays the associations of social interactions and interaction qualities with ambulatory BP. Unstandardized regression coefficients (*B*) are reported for all within-person analyses to illustrate the increase in SBP or DBP (mmHg) associated with a current or recent social interaction (Specific Aim 1) or given interaction quality (Specific Aim 3). Standardized regression coefficients (*β*) are reported for between-person analyses to illustrate the increase in SBP or DBP (mmHg) associated with a one-SD increase in the level-2, social interaction variable (Specific Aim 2) or the given level-2, interaction quality variable (Specific Aim 4).

Social Interaction and Ambulatory Blood Pressure (Specific Aims 1 And 2)

Results from multi-level models indicated that after controlling for time-varying (posture, temperature, activity level, food consumption, drug consumption) and person-level covariates (age, smoking status, BMI, educational attainment, yearly household

Table 4. Results from Controlled Models Examining the Associations of Social Interaction and Interaction Quality with Ambulatory Blood Pressure Reactivity, Average Daytime and Nighttime Levels, and Nocturnal Dipping

	Within-Person Analyses[1]		Between-Person Analyses[2]					
	B^3 [95% CI]		β^4 [95% CI]					
	Reactivity		Daytime Means		Nighttime Means		Nocturnal Dipping	
Variable	SBP	DBP	SBP	DBP	SBP	DBP	SBP	DBP
Social interaction[5]	1.55***	1.52***	0.06	0.61	-0.96	-0.31	0.008*	0.011*
	[1.03; 2.08]	[1.14; 1.90]	[-1.43; 1.55]	[-0.31; 1.53]	[-2.36; 0.45]	[-1.16; 0.55]	[0.004; 0.016]	[0.001; 0.019]
Interaction Quality								
High Affiliation								
Received support	1.31***	1.00***	-2.03*	-0.56	-2.20*	-1.28*	0.004	0.010§
	[0.64; 1.98]	[0.53; 1.47]	[-3.90; -0.17]	[-1.71; 0.60]	[-3.95; -0.44]	[-2.34; -0.22]	[-0.006; 0.014]	[-0.001; 0.022]
Provided support	-0.20	-0.10	-0.37	-0.10	0.23	-0.15	-0.004	0.001
	[-0.89; 0.49]	[-0.56; 0.36]	[-2.71; 1.96]	[-1.53; 1.34]	[-1.97; 2.43]	[-1.48; 1.19]	[-0.017; 0.008]	[-0.013; 0.015]

(table continues)

Table 4. Results from Controlled Models Examining the Associations of Social Interaction and Interaction Quality with Ambulatory Blood Pressure Reactivity, Average Daytime and Nighttime Levels, and Nocturnal Dipping, Continued

Low Affiliation								
Disagreement	0.13	0.14	0.83	0.68	1.48*	1.14**	-0.006	-0.008§
	[-0.73; 0.99]	[-0.50; 0.78]	[-0.69; 2.36]	[-0.25; 1.62]	[0.05; 2.91]	[0.28; 2.01]	[-0.014; 0.002]	[-0.017; 0.001]
Unfair treatment	0.72	0.85	0.72	0.08	0.81	0.26	-0.002	-0.003
	[-0.87; 2.31]	[-0.32; 2.02]	[-0.67; 2.10]	[-0.76; 0.92]	[-0.48; 2.10]	[-0.52; 1.04]	[-0.010; 0.005]	[-0.011; 0.005]
High Control								
In charge	-0.31	0.07	-1.22	-0.70	-0.76	-0.32	-0.002	-0.004
	[-1.05; 0.43]	[-0.47; 0.61]	[-3.73; 1.30]	[-2.24; 0.85]	[-3.14; 1.62]	[-1.76; 1.12]	[-0.015; 0.012]	[-0.019; 0.012]
Low Control								
Bossed around	0.06	-0.52	0.96	0.62	0.25	0.39	0.005	0.001
	[-0.84; 0.96]	[-1.18; 0.14]	[-0.59; 2.50]	[-0.33; 1.56]	[-1.21; 1.71]	[-0.50; 1.27]	[-0.004; 0.013]	[-0.008; 0.011]

§p < .10. *p < .05. **p < .01. ***p < .001.

CI = confidence interval. DBP = diastolic blood pressure. SBP = systolic blood pressure.

[1] Analyses controlled for time-varying covariates (posture, temperature, activity level, food consumption, drug consumption) and person-level covariates (age, smoking status, body mass index, educational attainment, yearly household income, and preferred language).

[2] Analyses controlled for person-level covariates only. BP summary values calculated using all available BP data (i.e., BP values with and without matched diary entry).

[3] Unstandardized regression coefficients (B) reflect the average increase or decrease in BP (in mmHg) associated with a social interaction or the respective interaction quality.

[4] Standardized beta coefficients ( ) reflect the average increase or decrease in the outcome of interest (in mmHg for mean daytime and nighttime BP; in % for nocturnal BP dipping) given a one-standard deviation increase in the respective social interaction or interaction quality predictor.

[5] Analyses involving "any social interaction" included matched diary entries in which a recent or current social interaction did (coded 1) and did not occur (coded 0) (total level-1 N = 12,346); all other analyses were limited to matched diary entries during which a recent or current social interaction did occur (total level-1 N = 6,679). The same N=260 participants were included in all analyses.

income, and language), SBP (B = 1.55, p < .001) and DBP (B = 1.52, p < .001) were

higher when measured in conjunction with current or recent social interactions relative to

observations that did not involve a current or recent social interaction. With control for

person-level covariates, between-person analyses indicated that higher social interaction

frequency related to greater nocturnal dipping (SBP: β = 0.008, p = .047; DBP: β =

0.011, p = .02), but was not significantly associated with mean nighttime or daytime BP

(all ps > .10).

Interaction Quality and Ambulatory Blood Pressure (Specific Aims 3 And 4)

Analyses investigating interaction quality and ambulatory BP were limited to

observations involving a current or recent social interaction, and controlled for the same

time-varying and person-level covariates listed above. Results from these analyses are

depicted in Table 4. At the within-person level, SBP and DBP were regressed (in separate

multilevel models) on all interaction quality variables simultaneously (i.e., received

support, provided support, disagreement, unfair treatment, in charge, bossed around).

Findings indicated that SBP (B = 1.31, p < .001) and DBP (B = 1.00, p < .001) were

higher when measured in conjunction with social interactions that involved receiving

support relative to observations that did not involve support receipt. No statistically

significant effects were observed for any of the other interaction quality variables (all ps

> .05).

Subsequent analyses investigated between-person associations of interaction

quality with BP summary measures (see Table 4). Holding overall social interaction

frequency constant, participants who reported receiving more support exhibited

significantly lower mean daytime SBP (β = -2.03, p = .03), and lower mean nighttime

SBP (β = -2.20, p = .01) and DBP (β = -1.28, p = .02) than those receiving relatively less support. In contrast, participants reporting a greater number of disagreements exhibited higher mean nighttime SBP (β = 1.48, p = .046) and DBP (β = 1.14 p < .01) than those who encountered less conflict. Marginally significant trends were observed for associations of more received support (β = 0.01, p = .07) and fewer disagreements (β = -0.008, p = .09) with greater nocturnal DBP dipping. Providing support, unfair treatment, feeling in charge, and feeling bossed around were not significantly related to any BP mean or nocturnal dipping outcomes.

Family/Friend Presence as a Moderator of Interaction Quality Effects (Exploratory Aim)

The within-person association between receiving support and SBP was significantly moderated by the presence of family and or friend(s) during the interaction (p = .03). All other "family/friend present-by-interaction quality" interaction effects were non-significant. The statistically significant interaction effect was followed up with simple slope analyses investigating the main effects of receiving support on SBP when friends/family were (sub-analysis 1) and were not present (sub-analysis 2). Analyses limited to interactions with friends/family were reduced by N = 3 women who did not report any interactions with friends or family during the monitoring period (remaining level-1 N = 4922; level-2 N = 257); N = 25 women who reported that all interactions involved friends or family were excluded from analyses investigating interaction-BP associations in the absence of friends/family (remaining level-1 N = 1757; level-2 N = 235). Findings indicated that supportive interactions related to higher SBP (versus interactions that did not involve support) when friends and/or family were present (B =

1.15 $p < .01$); however, the support-SBP association was relatively smaller in magnitude and not statistically significant when the supportive exchange occurred in interactions that did not involve friends and/or family ($B = 0.27$, $p = .46$).

Subsequent analyses investigated whether the between-person associations of interaction quality were moderated by family/friend presence. No statistically significant "family/friend presence-by-interaction quality" interaction effects were observed (all ps > .10).

Chapter 4: Discussion

This study was the first to explore the role of momentary social experiences in ambulatory BP in a homogeneous Latino sample. In a sample of healthy, middle-aged, Mexican-American women residing near the US-Mexico border in San Diego County, this investigation examined associations of social interactions and interaction qualities with acute BP reactivity and summary measures of ambulatory BP that have demonstrated associations with CVD in prior research (i.e., mean daytime and nighttime BP, nocturnal BP dipping). Analyses revealed that momentary SBP and DBP were an average of 1.55 mmHg and 1.52 mmHg higher (respectively) in the context of a current or recent social interaction relative to observations that did not involve a social interaction; participants with higher overall social interaction frequency also exhibited greater nocturnal BP dipping. Specifically, for every additional ~13 social interactions (of any kind) reported during the monitoring period, SBP and DBP dipping increased by approximately 0.8% and 1.1%, respectively.

In regard to interaction quality, momentary SBP and DBP were an average of 1.31 mmHg and 1.00 mmHg higher (respectively) when measured in conjunction with interactions that involved receiving support compared to those that did not entail support receipt; however, the association between support and SBP was larger (and only statistically significant) when a family member and/or friend was present during the interaction. At the aggregate level, an increase of ~9 supportive interactions was associated with roughly a 2.03 mmHg decrease in mean daytime SBP, and 2.20 mmHg and 1.28 mmHg decreases in mean nighttime SBP and DBP, respectively. A decrease of ~3 disagreements over the monitoring period was associated with 1.48 mmHg and 1.14

mmHg reductions in mean nighttime SBP and DBP, respectively. Trends were also observed for support and disagreements and greater/lesser nocturnal (DBP) dipping, respectively. No statistically significant associations were observed for ambulatory BP and social experiences involving support provision, unfair treatment, or feeling in charge or bossed around.

Interpersonal Theory in the Latino Population

Affiliation and control compose the two axes of the IPC, a central component of the interpersonal model. Prior research investigating these IPC dimensions in CVD has suggested protective effects of high affiliation (Barth et al., 2010; Low et al., 2010; Shaya et al., 2010) and deleterious effects of low affiliation on health (Brondolo et al., 2011; Pascoe & Smart Richman, 2009; Schoenthaler et al., 2010). Investigations using EMA to explore the associations of momentary social experiences with ambulatory BP have reported similar patterns (Brondolo et al., 1999; Karlin et al., 2003; Schoenthaler et al., 2010). Previous findings for control have been somewhat less consistent; global, retrospective indicators have exhibited positive associations with CVD severity (Newton, 2009), whereas EMA estimates of perceived momentary control have related negatively to momentary and mean ambulatory BP (Bishop et al., 2003; Kamarck et al., 2002). It was hypothesized that social interactions marked by high affiliation or control would be associated with momentary decreases in ambulatory BP, lower BP averages, and greater nocturnal BP dipping in the present study; the opposite was predicted for low affiliation and low control social experiences.

In this sample of Mexican-American women, high affiliation experiences (i.e., receiving support) were associated with *higher* momentary BP than social experiences

that were not marked by high affiliation (especially in the context of family and/or friends). Cumulatively however, having a greater number of high affiliation (and fewer low affiliation) social experiences appeared health-protective. In contrast, the present study did not lend support for the role of control in ambulatory BP in Mexican-American women. This finding is inconsistent with control-BP associations observed in prior investigations (Bishop et al., 2003; Kamarck et al., 2002; Kamarck et al., 1998); however, as noted previously, these studies did not limit observations to social experiences and were not conducted with Latino participants. Thus, this investigation is indeed the first to describe the role (or lack thereof) of momentary control in social experiences to cardiovascular health in Latinos.

In summary, this study provides preliminary evidence for the relevance of social interactions, and in particular, interactions marked by high and low affiliation (but not high/low control), to ambulatory BP in Mexican-American women. Findings highlight these particular aspects of the social environment as factors that may shape resilience (via greater interaction frequency, higher levels of support) and risk (via lower interaction frequency, higher conflict/disagreements) in this population. For instance, social interaction frequency and high affiliation experiences may form part of the health-protective buffer against social adversity that has been observed previously in Latinos (Arias et al., 2010; Markides & Eschbach, 2005; Palloni & Arias, 2004); however, this hypothesis was not directly examined in this study. Nonetheless, given the purported emphasis on personal relationships and family in the Latino culture, it follows that the social environment holds potential implications for cardiovascular health in this group (Gallo et al., 2009; Sanchez-Burks et al., 2000). Latinos (as a whole) are believed to

embrace a set of shared cultural values of purported relevance to mental and physical well-being (e.g., allocentrism, familism, simpatìa; Marin & Marin, 1991). *Simpatìa* represents the desire for pleasant and non-confrontational social interactions, while *allocentrism* and *familism* reflect a collective view in which the needs of the group or family are given precedence over those of the individual; strong attachments to family are emphasized. Prior research examining cross-cultural differences in related personality dimensions showed Mexico to rank 32nd out of 53 cultures on the Individualism dimension; the US ranked first (Hofstede, 2001). In addition, Mexico and the US ranked fifth and 38th respectively on the Power Distance Dimension, suggesting relatively greater acceptance of unequal power and status in Mexican culture (Hofstede, 2001). Taken together, these cultural values and related personality dimension rankings indeed corroborate the observed roles of social integration and high/low affiliation, but not social control, in the cardiovascular health of Mexican-American women.

Potential Mechanisms Linking Social Experiences with Ambulatory Blood Pressure

Although the present study did not investigate mediation, a variety of physiological mechanisms, health behaviors, and psychosocial risk factors may contribute to the observed associations between momentary social experiences and ambulatory BP. The research reviewed below highlights potential underlying mechanisms that should be considered in future (longitudinal) research exploring indirect pathways.

Physiological Mechanisms

As part of the stress or "fight-or-flight" response, stimuli in the environment (e.g., stressors) activate the sympathetic nervous and neuroendocrine (hypothalamic-pituitary-

adrenal [HPA] axis) systems. In this process, epinephrine (adrenaline) and norepinephrine (noradrenaline) are released by the adrenal medulla, which leads to physiological arousal – e.g., increased heart rate, constricted blood vessels, and elevated blood pressure. The hypothalamus also releases corticotropin-releasing factor, which triggers the release of adrenocorticotropin hormone (ACTH). In turn, ACTH stimulates cortisol production and secretion. The reactivity hypothesis (Lepore, 1998) links elevated physiological reactivity with higher risk for CVD development and progression. However, research has shown that the social network (particularly through the provision of support) can be health-protective by buffering neuroendocrine and sympathetic nervous system responses to stress (Southwick, Vythilingam, & Charney, 2005; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). The cardiovascular reactivity that occurred in the context of interacting (versus not) in the present study is to be expected, given the physiological activation associated with talking (Kamarck et al., 2002). However, because the support-BP reactivity associations were observed in separate analyses that were limited to social interactions only (and thus essentially controlled for the influence of talking on BP), it was indeed surprising that ambulatory BP was *higher* when measured in conjunction with social interactions that involved support versus those that did not. Although these analyses controlled for other qualities of social interactions and several relevant time-varying covariates (i.e., posture, temperature, activity level, food consumption, drug consumption), they did not take other potential explanations for the support-related BP increases into account. For instance, perhaps the reason for which one was receiving support (e.g., stress, emotional distress), as opposed to the support itself, contributed to the significant increase in ambulatory BP. Previous research has

consistently shown ambulatory BP to be higher during daily experiences of psychosocial stress assessed via EMA (e.g., task demand, decisional control, negative affect, arousal, conflict; for a review see Kamarck et al., 2005). If receiving support was indeed a proxy for stress in this study, one would expect BP reactivity to have been even greater if support was not available to buffer the stress-related physiological response. Nonetheless, without directly accounting for momentary levels of psychosocial stress, this proxy explanation is merely speculative.

Also contrary to a priori hypotheses, the support-SBP association was significantly *larger* in magnitude (and only statistically significant) in the presence of family and/or friends. This finding is inconsistent with prior research suggesting a buffering effect of familiar individuals on the association between social experiences and cardiovascular reactivity (Gump et al., 2001; Holt-Lunstad et al., 2003). It has been posited that, because interactions with unfamiliar individuals occur less frequently and involve greater uncertainty than those with family or friends, the former are more likely to be associated with a defense reaction (Julius, 1995) or hypervigilance (Gump & Matthews, 1998), thus resulting in heightened BP reactivity (Gump et al., 2001). However, the opposite was observed in this sample of Mexican-American women. Additional research that looks more closely at the specific content or context of social interactions, or their emotional sequelae might provide greater insight into the current findings.

Physiological mechanisms may also underlie associations of social experiences with average BP levels and nocturnal BP dipping. For instance, research shows that chronic stress combined with low social support may affect health via prolonged

sympathetic activation (Uchino, 2006), and thus, reduced "recovery" (e.g., blunted

nocturnal BP decline). Ozbay et al. (2007) go further to describe resilience to stress as

"an ability to keep the HPA axis and noradrenergic activity within an optimal range

during stress exposure and terminate the stress response once the stressor is no longer

present" (p. 36). In fact, evidence suggests that higher nighttime BP and reduced BP

dipping may be a product of an *imbalance* between sympathetic and parasympathetic

nervous system activity – in particular, the failure to shift from a sympathetic to

parasympthetic tone during sleep (Kanbay, Turgut, Uyar, Akcay, & Covic, 2008). More

specifically, research has shown the nondipping pattern to be associated with decreased

parasympathetic nervous system activity (Nakano et al., 2001), increased sympathetic

nervous system activity, and higher levels of epinephrine and norepineprhine during the

night (Sherwood et al., 2011; Sherwood, Steffen, Blumenthal, Kuhn, & Hinderliter,

2002). Thus, whereas momentary social interactions (perhaps due to the influence of

talking on cardiovascular activity) and momentary support receipt (perhaps as a proxy for

stress) were both associated with acute increases in ambulatory BP, the cumulative

effects of social interactions, and receiving support in particular, predicted healthier BP

patterns in the present sample - perhaps through one or more of the mechanisms

described above (e.g., expedited termination of the physiological stress response;

facilitation of sympathetic-parasympathetic shift). Given the research reviewed above, it

also follows that cumulative levels of conflict/disagreement predicted the opposite pattern

– i.e., higher mean nighttime BP.

Health Behaviors and Psychosocial Risk Factors

A variety of BP-relevant health behaviors may contribute to the associations

between social experiences and ambulatory BP. Specifically, prior research has shown

greater social integration and support, and lower levels of conflict to predict higher

physical activity levels (Jonsson, Rosengren, Dotevall, Lappas, & Wilhelmsen, 1999;

Oka, King, & Young, 1995; Shankar, McMunn, Banks, & Steptoe, 2011) and healthier

dietary patterns (Eng, Kawachi, Fitzmaurice, & Rimm, 2005; Harrington et al., 2011). In

turn, significant associations have been observed between these health behaviors and

lower mean ambulatory BP (for a review see Whelton, Chin, Xin, & He, 2002) and

greater nocturnal BP dipping (Agarwal & Light, 2010; Leary, Donnan, MacDonald, &

Murphy, 2000; Park, Jastremski, & Wallace, 2005; Wilson, Sica, & Miller, 1999).

Further, it is likely that exercise and diet affect BP via their association with obesity,

since greater adiposity is consistently associated with greater ambulatory BP (and lesser

BP dipping) in lean and overweight adults and children (for a review see Ben-Dov &

Bursztyn, 2009). Lower levels of social support and integration, and higher perceived

isolation (i.e., loneliness) have also been linked with reduced sleep quality and quantity

(Costa, Ceolim, & Neri, 2011; Runeson, Lindgren, & Wahlstedt, 2011; Vitaliano et al.,

2002), and a greater likelihood of smoking (Shankar et al., 2011; Vaananen, Kouvonen,

Kivimaki, Pentti, & Vahtera, 2008), all of which in turn predict higher mean BP and

reduced BP dipping (Campbell, Key, Ireland, Bacon, & Ditto, 2008; Henskens et al.,

2011; Huang et al., 2011; Loredo, Nelesen, Ancoli-Israel, & Dimsdale, 2004; Matthews

et al., 2008; Morillo, Amato, & Cendon Filha, 2006). It is also possible that higher social

contact frequency, greater support, and fewer disagreements predict more optimal values

on BP summary measures by preventing or reducing the severity of a variety of

psychosocial risk factors (e.g., depression, anxiety, hostility) that in turn predict higher

BP and/or a non-dipping pattern (Hamer et al., 2012; Kario, Schwartz, Davidson, &
Pickering, 2001; Ma, Kong, Qi, & Wang, 2008) at least in part via associations with
many of the above-mentioned health behaviors (e.g., sleep; Grano, Vahtera, Virtanen,
Keltikangas-Jarvinen, & Kivimaki, 2008; Mezick et al., 2010; Spira, Stone, Beaudreau,
Ancoli-Israel, & Yaffe, 2009).

Implications

In addition to exhibiting improved reliability (Campbell et al., 2010; Trazzi et al.,
1991), ambulatory BP averages and nocturnal dipping have been found to be better
predictors of CVD outcomes than resting clinic BP assessments (Dolan et al., 2005;
Pickering et al., 2006; Sega et al., 2005), with some studies indicating BP dipping to have
the best prognostic utility of the summary measures (Fagard, Thijs et al., 2008; Ohkubo
et al., 2002; Staessen et al., 1999). In fact, Ohkubo et al. found that a 5% increase in
nocturnal BP dipping was associated with an approximately 20% lower risk of
cardiovascular mortality. Drawing on these findings, the improvements in BP dipping
associated with an increase of ~13 social interactions (of any kind) in the present study
translate to a relative risk reduction of roughly 3 to 8% for cardiovascular mortality. For
average BP levels, the most consistent findings were observed for mean nighttime SBP
and DBP in the present sample. Notably, several longitudinal studies have found mean
nighttime BP to be a better predictor of CVD risk than daytime or 24-hour averages
(Ben-Dov et al., 2007; Dolan et al., 2005; Fagard, Celis, et al., 2008; Hansen et al., 2011;
Kikuya et al., 2005). The reductions in mean nighttime SBP and DBP (associated with an
increase of ~9 high affiliation or ~2 low affiliation social experiences) in the current

study equate to an approximate 3.5 to 6% reduction in cardiovascular risk based on estimates from previous research (Hermida, Ayala, Mojon, & Fernandez, 2011).

As depicted by these estimates of clinical relevance, the social environment represents an important consideration in hypertension screening and treatment. Social experiences may play a particularly central role in the cardiovascular health of groups that generally emphasize and value supportive, social relationships (e.g., Latinos). Identifying potentially modifiable risk factors for elevated BP and blunted dipping can help identify targets for programs aiming to reduce risk in healthy individuals and improve outcomes in those with diagnosed CVD. Disentangling the factor(s) that contribute to the associations of social experiences with ambulatory BP (e.g., physiological mechanisms, health behaviors, psychosocial risk factors) would serve to further tailor these intervention efforts. In addition to exploring mechanisms, investigations are needed to explore the stability of social experience-ambulatory BP associations across a variety of participant characteristics. In particular, research has shown associations of high/low affiliation experiences with ambulatory BP to be moderated by trait hostility levels. To illustrate, trait hostility moderated the effects of hostile interactions on DBP reactivity, such that increases in negative interaction intensity was associated with increases in DBP for participants with high, but not low, hostility (Brondolo et al., 2003). Similarly, research has shown ambulatory BP to increase significantly during low affiliation (i.e., "potentially quarrelsome") social interactions among participants with high, but not low trait hostility (Brondolo et al., 2009; Enkelmann et al., 2005). In another study, social interactions rated as "supportive" (i.e., high affiliation) corresponded to increases in ambulatory BP among high- but not low-

hostile individuals, whereas "intimate" interactions were associated with decreases in ambulatory BP among low-hostile individuals (only) (Vella et al., 2008). Findings may also vary significantly across demographic subgroups. Findings from Troxel et al. (2010) showed the link between social contact frequency (assessed via EMA) and nocturnal BP dipping to be significantly stronger among African-American, relative to White participants (Troxel et al., 2010). Studies using traditional self-report measures of social experiences have also reported significant variability in associations with ambulatory BP across ethnic (e.g., Black and White participants; Cooper et al., 2009) and gender groups (e.g., Spruill et al. 2009). These and other findings suggest that more investigations are needed to further explore these relationships in homogeneous samples, or in heterogeneous samples of sufficient size to permit subgroup analyses. Studies that combine heterogeneous groups for analysis, or that do not consider race/ethnicity, gender, and/or age as potential moderators may report findings that mask important subgroup differences. Furthermore, the use of EMA in these studies is preferred whenever feasible, as measuring social experiences "in vivo" may indeed provide a more accurate picture of how social relationships and interactions shape cardiovascular morbidity and mortality (Troxel et al., 2010).

Limitations

The current study provides novel information about the roles of social experiences in ambulatory BP in an understudied population. However, findings should be considered in light of the following limitations. First, the cross-sectional design precludes causal conclusions; additional (prospective) research is needed to determine whether these social experiences indeed *lead* to more optimal BP patterns, and whether modifying these

factors affects ambulatory BP over time. Second, because previous research has shown normotensive individuals to exhibit smaller BP responses to psychosocial phenomena than hypertensive individuals (Georgiades, Lemne, de Faire, Lindvall, & Fredrikson, 1996), range restriction may have limited our ability to detect associations between some social experiences and ambulatory BP in this sample of healthy (i.e., free of physician-diagnosed major health conditions, including hypertension), middle-aged women. Third, our ability to observe statistically significant, within-person effects in simple slope models (Exploratory Aims) may have been limited by the reduced (sub)sample sizes in stratified analyses. Reliance on a single night of ambulatory monitoring (and therefore, a reduced number of nighttime BP values), and on self-reported sleep and wake times rather than an objectively quantified indicator of sleep (e.g., actigraphy) are additional limitations, which may have introduced error differentiating nighttime from daytime BP values, and in calculating nocturnal BP dipping levels. Further, although EMA provides many advantages over retrospective, self-report surveys (Kamarck et al., 2011; Shiffman et al., 2008), one disadvantage is that EMA items must be relatively small in quantity and short in length to avoid undue participant burden and significant disruptions in daily activities. As a result, the amount of detail that can be ascertained about daily experiences is limited. Obtaining additional information about the *type*(s) of support (e.g., emotional, tangible, informational) and/or conflict that are most relevant to health would help to narrow the focus of psychosocial interventions targeting correlates of CVD. Further, it was speculated that the acute BP increases that were observed in the context of receiving support may be attributable to factors that were not accounted for by the present study (e.g., the reason for which one was provided with support); however, future studies are

needed to confirm or refute this hypothesis. Investigating general mechanisms (e.g., physiological, behavioral, psychosocial) was also beyond the scope of this paper, but is an important direction for future (longitudinal) research. Lastly, these findings should be interpreted in the context of sample characteristics (i.e., Mexican-American women residing near the US-Mexico border), and may not be generalizable to other segments of the Latino population.

Conclusions

Despite these limitations, this study represents an important contribution to the literature. Specifically, this investigation was the first to examine the role of social experiences, assessed via an EMA paradigm, in ambulatory BP in a homogeneous Latino sample. Consistent with previous research conducted in other populations (Brondolo et al., 1999; Brondolo et al., 2003; Guyll & Contrada, 1998), ambulatory BP was significantly higher in the context of a current or recent social interaction relative to observations that did not involve an interaction; participants with higher overall social interaction frequency also exhibited greater nocturnal BP dipping. *Qualitative* aspects of social experiences, especially affiliation, also related to BP in this sample of Mexican-American women. The role of affiliation in the cardiovascular activity of this group is not surprising, given the centrality of extended family and other supportive social relationships the Latino population on the whole. Taken together, findings suggest that social contact and support may contribute to some of the better-than-expected CVD outcomes in this group. Further, these features of the social environment are important considerations for hypertension screening and treatment. However, additional research is needed to corroborate these findings in this relatively understudied population. Potential

mediators (e.g., physiological, behavioral, psychosocial) and moderators (e.g., age, gender, race/ethnicity, ethnic subgroup, hostility) of the associations between social experiences and ambulatory BP also warrant attention in future studies.

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