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Age Differences in Adults' Daily Social Interactions: An Ecological Momentary Assessment Study

Ruixue Zhaoyang[1,*], **Martin J. Sliwinski**[1,2], **Lynn M. Martire**[1,2], and **Joshua M. Smyth**[1,3]

[1]Center for Healthy Aging, Pennsylvania State University

[2]Department of Human Development and Family Studies, Pennsylvania State University

[3]Department of Biobehavioral Health, Pennsylvania State University

Abstract

Prevailing research suggests that social relationships get better with age, but this evidence is largely based on studies with lengthy reporting intervals. Using an ecological momentary assessment approach, the present study examined age differences in several characteristics of social interactions as reported in near real-time: the frequency, quality and partner type. Participants (N = 173) aged 20 to 79 years reported their social interactions at five random times throughout the day for one week. Results revealed that age was associated with higher frequency of interacting with family and lower frequency of interacting with peripheral partners. These age effects, however, became non-significant after accounting for contextual factors such as race, gender, education, employment status, family structure and living arrangement. In contrast, a curvilinear relationship best characterized age differences in both positive and negative ratings of daily social interaction quality, with middle-aged adults reporting the lowest positive ratings and older adults reporting the lowest negative ratings among all ages. Contextual factors did not account for these patterns of age differences in relationship quality. Furthermore, the intraindividual variability of interaction frequency with peripheral partners, partner diversity, and interaction quality (positivity and negativity) was lower among older adults than younger adults. Findings from the present study portray a nuanced picture of social interactions in daily life and advance our understanding of social interactions across the lifespan.

Keywords

age differences; social interaction; ecological momentary assessment; social relationships; intraindividual variability

Because most human behaviors take place in social contexts, interactions with others are among the most important experiences in daily life. From daily social interactions, people obtain knowledge and information, acquire and maintain self-identity, select friends and

*Corresponding Author: Ruixue Zhaoyang, PhD., Center for Healthy Aging, The Pennsylvania State University, 408 Biobehavioral Health Building, University Park, PA 16802, rzzl2@psu.edu, Phone: +1 814-863-9978.

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mates, exchange instrumental and emotional support with others, and also encounter and resolve conflicts with others. Indeed, a growing number of studies provide strong evidence that the quantity and quality of daily social interactions are associated with psychological well-being and a variety of health outcomes for people of different age groups (e.g., Bernstein, Zawadzki, Juth, Benfield, & Smyth, 2017; Cundiff, Kamarck, & Manuck, 2016; Pauly, Lay, Nater, Scott & Hoppmann, 2017). We are not aware of prior research, however, that has systematically examined age differences in important characteristics of daily social interactions, such as frequency, partner type and quality. The primary goal of the present study was to examine age differences in average levels and intraindividual variability of several important characteristics of social interactions in near real-time and as individuals go about their daily lives. In addition, we further explored different sources of age differences in daily social interactions.

Age Differences in Social Interactions

Research examining individuals across the lifespan suggests change as well as stability in social relationships. For example, a recent meta-analysis of 277 studies on age-related social network changes found that the size of family networks remains stable throughout the lifespan, whereas global, personal (e.g., family, friends and other close confidants), and friendship networks expand during adolescence and young adulthood, reach a plateau until early 30s, and shrink during later adulthood (after 65 years old, Wrzus, Hanel, Wagner, & Neyer, 2013). Similar results were also reported by English and Carstensen (2014) in their 10-year longitudinal study, in that the size of social networks increased until middle age, then decreased gradually throughout late middle and old age as the number of peripheral partners within the network decreased. Past longitudinal research also provides evidence that the frequency of interacting with family members remains stable or even increases throughout adulthood whereas interaction frequency with acquaintances and friends declines from early adulthood on (Carstensen, 1992; Kalmijn, 2012). Regarding age-related changes in relationship quality, there is growing evidence that older adults have better social relationships compared with young and middle-aged adults (see Luong, Charles, & Fingerman, 2011 for a review). For example, compared with young and middle-aged adults, older adults report higher satisfaction with their social networks and relationships (Carstensen, 1992; Lansford, Sherman, & Antonuicci, 1998) and lower intensity of negative emotions or distress caused by social partners (Charles & Piazza, 2007; Birditt & Fingerman, 2003). Observational studies also provide evidence that older couples perceive their marital partners more positively and report less conflict than do young couples (Story, et al., 2007) and middle-aged couples (Levenson, Carstensen & Gottman, 1993; Smith et al., 2009).

Theories on the lifespan development of social relationships interpret age-related differences in social interactions from different perspectives. Some theories attribute age-related changes in social relationships to changes that reside within the individual. For example, Socioemotional Selectivity Theory (SST, Carstensen, 1992; Carstensen, Isaacowitz, & Charles, 1999) posits that older adults place greater priority on emotional and social goals compared with their younger counterparts because they are facing relatively shorter futures. Therefore, older adults are motivated to interact with close partners who are more likely to

satisfy their emotional needs and avoid partners who are less likely to do so (English & Carstensen, 2014). Older adults are also thought to have more social experience and expertise to avoid conflict during social interactions (e.g., Hess, 2005) and a cognitive bias where they attend to positive experience and thus appraise their social interaction experiences more positively (Charles, Mather & Carstensen, 2003; Luong et al., 2011).

Other theories hold that social relationships are both developmental and contextual in nature so that social relationships are not only affected by individuals' changing capacities, goals, and motives, but also affected by changes in individuals' circumstances or contexts across the lifespan (Antonucci, Fiori, Birditt, & Jackey, 2011; Kahn & Antonucci, 1980). Particularly, the Social Convoy Model proposes that individuals' relationships are shaped by both personal (e.g., gender, race) and situational (e.g., role expectations, resources, demands) factors during different life stages (Antonucci, Ajrouch, & Birditt, 2014). Personal characteristics shape the types of social relationships an individual is likely to seek, need, and develop whereas situational circumstances create different roles, expectations, and demands, which can influence an individual's social relationships. For example, common transitions during young adulthood and midlife, such as job entry, marriage, and parenthood are likely to expand individuals' social network by adding coworkers, indaws, and children. At the same time, the multiple roles and competing demands related to work and family may lead to more stress and strain in social relationships during midlife (Antonucci, 2001). Older adults may have more free time and reduced number of competing demands but also reduced chances of interacting with different types of partners due to retirement, living alone or widowhood. Additionally, certain aspects of the social convoy, such as the relationships with family, are more likely than others to remain stable under changing circumstances (Antonucci, 2001; Wrzus et al., 2013).

Taken together, lifespan theories and past research underscore the importance of considering the heterogeneity of social interaction experiences and attending to both personal and contextual factors for a better understanding of the variations of social interactions across the lifespan. Therefore, the primary goals of our study were to examine age differences in daily social interactions and the degree to which contextual factors shape the daily social interactions at different ages.

Several contextual factors have been identified by previous research as having important influences on social interactions at different ages. First, gender is an important component of individuals' social context and can shape their social experience across the life course (Antonucci et al., 2014). Gender theorists have long argued that compared with men, women's traditional gender roles encourage expressiveness, dependence, and nurturing behavior, which translates into a greater need for social interactions and more intimate relationships (Seccombe & Ishii-Kuntz, 1994; Umberson, Chen, House, Hopkins, & Slaten, 1996). Women are also more likely to be affected by age-related changes in social roles and responsibilities, such as parenting and elder caregiving starting from midlife (Ajrouch, Blandon, & Antonucci, 2005). As a result, women not only have significantly larger and more multifaceted social networks and more close partners than men across all ages, but also experience more age-related changes in social networks and relationships than do men

(Ajrouch et al., 2005; Antonucci et al., 2013). Therefore, it is important to consider the role of gender and how it interplays with age to shape social interactions.

Race is another important factor that influences individuals' social contexts. Minorities may incur more hardship such as economic deprivation and discrimination and have fewer opportunities than the dominant group, thus affecting who they can trust and interact with (Ajrouh et al., 2001). Previous research suggests that compared with Whites, social networks among non-Whites are smaller, more likely to include kin, and characterized by more frequent contact (Ajrouh et al., 2001; Cantor, Brennan, & Sainz, 1994).

Other contextual factors may contribute to the age-related variation in social interactions due to their occurrence and different prevalence at different life stages (Luhmann & Hawkley, 2016). For example, education and employment not only confers greater opportunity for individuals to form ties with more diverse (i.e., non-family) partners, but also provides individuals with greater cognitive resources and skills that are needed to develop and sustain diverse social relationships (Antonucci, Ajrouch, & Janevic, 1999; Ajrouch et al., 2005; McPherson et al., 2001). Moreover, marriage and parenthood, both common circumstances as people enter adulthood, provide greater opportunity to have frequent interactions with family members but may reduce the time or need to interact with friends (Kalmijn, 2012). Additionally, interactions with spouses and children can be complex and bring both support and strain (Walen & Lachman, 2000). Finally, living with a partner or others (vs. living alone), which is more common among middle-aged adults than young and older adults (Luhmann & Hawkley, 2016), provides opportunities for frequent contact with social partners.

EMA Studies on Social Interactions

Despite a growing body of research on social network or relationships across the lifespan, there is a scarcity of research exploring age differences in the daily social interactions through which relationships are built and maintained. Previous research has mainly focused on measuring social network size or relationship quality in general or, at best, how people recall their interactions with certain social partners in previous days, weeks or months. As noted, daily social interactions may capture a different aspect of social connectedness than network size and general relationship quality (Cornwell, 2011). Specifically, daily social interactions provide valuable insight into real-time social exposure and access to companionship and social support whereas global, summary, or retrospective self-reports of social relationships are more likely to reflect enduring patterns of social interactions. In addition, the global retrospective measures used by the majority of previous studies may be more likely to be influenced by memory errors, retrieval biases and heuristics (Conner & Barrett, 2012), especially for older participants (Story et al., 2007), suggesting that this approach may not be ideal in research examining age differences in individuals' experiences (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000).

In response to these concerns, research is increasingly using methods – including ecological momentary assessment (EMA) – that assess people's experiences in (near) real-time as they unfold in daily life to study daily social interactions (e.g., Bernstein et al., 2017; Cundiff et

al., 2016; Pauly et al., 2016). Although sparse, there have been some studies to examine age differences in daily social interactions using EMA and daily diary methods. For example, older adults were found to spend substantially less time in social contact (Cornwell, 2011) and more time in solitude (Pauly et al., 2016) than young and middle-aged adults. Older age was also related to fewer daily arguments or tensions with others (e.g., Birditt, Fingerman, & Almeida, 2005; Charles, Piazza, Luong, & Almeida, 2009). In addition, recent EMA studies provide evidence that characteristics of social interaction (e.g., quality, partner type) not only vary across ages but also vary from day-to-day and moment-to-moment within an individual (Mejía & Hooker, 2013, 2015; Ram et al., 2014; Vogel, Ram, Conroy, Pincus & Cerstorf, 2017). This highlights the importance of considering intraindividual variability, the within-person variation in experience or behavior, for a better understanding of social interactions.

The Present Study

Previous EMA studies have focused on specific segments of the lifespan (e.g., older adulthood); specific types of partner (e.g., close partners); or one aspect of social interaction (e.g., interaction quality, Mejía & Hooker, 2013, 2015). Our study, in contrast, aims to provide a wholistic picture of daily social interactions across adulthood by examining the major features of social interactions (e.g., interaction frequency, partner type and diversity, and quality) with all types of partners in an adult lifespan sample. Furthermore, we aim to investigate the degree to which contextual factors shape the social interactions across ages as suggested by the Social Convoy Model (Kahn & Antonucci, 1980). Finally, although recent EMA studies examined the intraindividual variability in social interactions and its influence on other variables (e.g., affective experiences, Mejía & Hooker, 2013, 2015; Ram et al., 2014; Vogel et al., 2017), no prior study has examined age-graded differences in the intraindividual variability of social interactions. To fill this gap, the final aim of our study was to explore how the intraindividual variability of different aspects of social interactions varies with age.

Based on lifespan theories and previous findings (Kahn & Antonucci, 1980; Carstensen, 1992; Wrzus et al., 2013), we predicted that the frequency of social interactions with family members would remain stable across ages whereas the frequency of interactions with friends and peripheral relationship partners such as acquaintance, coworker, and stranger would diminish with age, resulting in a decrease in total interaction frequency with all types of partners. In addition, we expected that compared to young and middle-aged adults, older adults would be more likely to interact with family and friends rather than with other peripheral partners, and also interact with less diverse social partners. With regard to the quality of social interactions, we assessed both the positivity and negativity of the same interaction occasion, and predicted that older adults would report more positive and less negative daily social interactions compared with young and middle-aged adults. Based on the Social Convoy Model and previous research, we expected that contextual factors, such as gender, race, socioeconomic status, marital status, parenthood, and living arrangement could (at least partially) account for these age differences in social interaction frequency, partners and quality.

Finally, we expected to find age-related decreases in the intraindividual variability of social interactions. Intraindividual variability of behaviors is often explained as fluctuations or instability as a result of short-term processes such as regulation, reinforcement, or homeostasis (Nesselroade, 1991), or as a result of varied environment (Koffer & Ram, 2015). Given that older age is associated with less varied social contexts and improvement in the ability to regulate daily experiences (Carstensen et al., 2011; Charles, 2010), all aspects of social interaction experiences should vary less from day-to-day or moment-to-moment for older adults than younger adults. The contextual factors examined in our study (e.g., gender, race, marital status) did not capture the short-term environmental changes such as daily events or stressors which could contribute to the intraindividual variability of social interactions. Thus, we did not expect the contextual factors included in our study to be able to account for any age-related differences in intraindividual variability of social interactions.

Method

Participants

The present study utilized data from the ecological momentary assessment (EMA) portion of a larger longitudinal measurement burst study of cognition, health, and aging across the lifespan, approved by the Institutional Review Board of Syracuse University (see Mogle, Munoz, Hill, Smyth & Sliwinski, 2017 for details). Potential participants for the larger study (N = 214) were recruited from community-dwelling adults in upstate New York area via a diverse array of advertisements from 2010 to 2012. Eligibility requirements for the study included age (20 to 80 years old), fluency in English, physical ability to operate a palm top computer, and absence of major cognitive impairment. The sample for the present study included 173 participants (49% men) who completed the EMA component of the study and provided information on their age. Participants in the final sample did not significantly differ from those who were not included (N=41) in terms of age, gender, race, education, marital status and living arrangement. In the final sample, participants ranged in age from 20 to 79 years old (M = 49.39, SD = 16.99), and 58% of them self-identified as Caucasian, 31% as African American, 3.5% as Hispanic and 7.5% as others. About 75% of the participants had a high school degree or less and 25% had a bachelor or graduate school degree. Approximately 40% of the participants were employed and participants in the whole sample reported an average annual income of $26,998. Twenty-nine percent of the participants were currently married at the time of participation and 76% of the participants had children. In terms of living arrangement, 42% of the participants reported currently living alone and 58% reported living with family members, friends or others.

Procedure

Following the initial phone-screening, eligible participants completed the consent process, a demographics questionnaire and training in the use of the palmtop computer in the lab session. Participants were then invited to participate in a 2-day pre-screening study to practice and habituate to the EMA protocol. During the pre-screening study, participants completed a morning assessment, an evening assessment and up to five randomly beeped momentary assessments each day using a palmtop computer. The five beeped assessments were scheduled for pseudo-random times spaced approximately 2-3 hours apart throughout

the day. Participants who correctly completed at least one morning assessment, one evening assessment, and 6 out of 10 beeped assessments (60%) during the two days were invited to complete the full EMA study. To be considered correctly completed, beeped assessments had to be started within 30 minutes of the scheduled beep and could last no longer than 30 minutes from start to finish. Participants returned the palmtop computer within 4-5 days of the pre-screening study. Of the 188 individuals who participated in the pre-screening study, 177 (94%) were eligible to participate in the full study. Similar to the pre-screening study, those participants completed a morning assessment, an evening assessment and up to five randomly prompted assessments each day using a palmtop computer for seven consecutive days. After the EMA study, participants returned to the lab for a series of cognitive tests, and were debriefed and compensated for their participation.

This study used data from the beeped assessments of the full EMA study. Out of a potential 6055 beeped momentary assessments (173 individuals with age information × 7 days × 5 beeped assessments per day), a total of 5359 assessments were completed (89%). At the person level, each participant completed on average 31 (SD = 5.89, $Range$ = 5-35) momentary assessments over the 7-day study period. More than 94% of the participants (N = 163) completed at least 60% of potential momentary assessments (N = 21) over the 7-day study period. Missing data analyses at the person level revealed that the number of completed momentary assessments was not significant associated with participants' age, gender, race, education level, income, employment status, marital status or number of children, but was significantly associated with living arrangement. Participants who were living alone completed fewer assessments than did those who were not living alone (Ms = 30 *vs*. 32, $F[1,172]$ = 8.43, p = 0.004). Later analyses suggested that excluding participants (N = 10) who completed less than 60% of the assessments did not change any results. Therefore, we used data from all participants (N = 173) in our analyses.

Measures

Participants were told that a social interaction is defined as talking to someone in person, by phone, or online.

Social interaction partner.—At each momentary assessment, if participants reported having one or more social interactions since the last assessment, they were asked to think about *the most recent* social interaction that they had and indicate with whom this interaction was by selecting all of the partners involved from a list including 14 types of relationship partners. On the basis of prior research and low frequencies of some types of partners, three categories were created: family members (e.g., spouse, child, parent, sibling or other family member), friends, and peripheral relationship partners (e.g., acquaintance, coworker, stranger, roommate, classmate, therapist, healthcare provider, or other person). A categorical variable was created to represent these three types of interactions (1 = *family only*, 2 = *friends only*, 3 = *others only*). Of the 2893 occasions that involved only one type of partner, 50.60% involved family members, 22.81% involved friends and 26.58% involved peripheral relationship partners.

Social interaction frequency.—Participants' total social interaction frequency with *all* partners was assessed at each momentary assessment by one item: "*Since the last assessment, how many social interactions have you had? "* Participants were asked to select a number from 0 to 10 (10 = *10 or more social interactions*). In addition, the frequency of social interactions with family, friends, or other peripheral partners respectively was calculated by counting the total number of interactions that were with family, friends, or peripheral partners each day based on participants' momentary assessments on their most recent social interaction. Therefore, the daily frequency of interactions with family, friends, or peripheral partners ranged from 0 to 5.

Social interaction quality.—At each momentary assessment, participants rated the quality of their *most recent* social interaction with two items: "*Overall, how pleasant or positive was this interaction?"* and *"Overall, how unpleasant or negative was this interaction?*" Each item was scored on a 7-point scale (1 = *not at all*, 7 = *extremely*). The positive rating and negative rating correlated at −.54 at within-person level and −.49 at between-person level, suggesting that they may have tapped different aspects of interaction quality. Previous studies using similar items suggest that positive and negative social interactions are best treated as separate constructs rather than opposite ends of a continuous dimension (e.g., Cundiff et al., 2016; Joseph et al., 2014).

Social contexts.—The personal and situational characteristics that compose participants' social context were measured at the baseline lab assessment and were coded as follow: gender (0 = *Male*, 1 = *Female*), race (0 = *non-White*, 1 = *White*), education (0 = *High school or less*, 1 = *Some college, college degree or graduate degree*), employment status (0 = *Not working*, 1= *Working for payment*), marital status (0 = *Not married*, 1 = *Currently married*), living arrangement (0 = *Live alone*, 1 = *Live with others*), and whether participants have any children (0*=No children*, 1=*Having one or more children*).

Data Analysis

We used multilevel modeling to examine age differences in daily social interaction experiences (Singer and Willett, 2003). The data were structured hierarchically, with momentary assessments (level 1) nested within days (level 2) and days nested within persons (level 3). Thus, social interaction characteristics could vary across occasions within a day, across days within a person as well as across persons. All analyses for continuous outcomes (i.e., frequency and quality of social interactions) were conducted using SAS (version 9.4) PROC MIXED with restricted maximum likelihood (REML) and robust standard error. Particularly, these multilevel models were extended to include age as the predictor of both the means and the heterogeneous level-1 residuals of the outcomes (e.g., the dispersion models in Hoffman, 2007). Analyses for categorical outcomes (i.e., partner type) were conducted using SAS PROC GLIMMIX with multinomial distribution and the generalized logit link function. The intraindividual variability of the categorical outcome was quantified using Shannon's (1948) entropy index following previous research (Ram, Conroy, Pincus, Hyde, & Molloy, 2012). This index also reflects the diversity of each individual's interaction partners. Specifically,

$$Interaction\ Partner\ Diversity = -\left(\frac{1}{\ln(m)}\right)\sum_{j=1}^{m} p_{ij}\ln p_{ij}$$

where m is the number of available partner types (e.g., m=14 in this study), and p^{ij} is the proportion of individual i's total social interactions with type j partner across the 7 days (j=1 to m). This score of interaction partner diversity can range from 0 (all interactions were with single type of partner) to 1 (interactions spread evenly across all types of partners). The age differences in interaction partner diversity were then examined in standard regression models.

We first examined whether daily social interactions (means and variability) varied with age in a series of random-intercept models in which age effects (linear and nonlinear) were included as predictors of both the mean and within-person variability of the outcome (Model 1). Lifespan theories and previous research on social relationships suggest that age-related changes in social relationships across the lifespan may not be linear (Carstensen, 1992; Cornwell et al., 2008; Wrzus et al., 2013), and thus we examined both linear and nonlinear effects of age and ended up including linear and quadratic age effects in all models after initial inspection of the data. Second, we examined whether age differences in social interactions can be accounted for by a set of contextual factors by adding these factors to each model (Model 2). We then inspected the regression coefficients in a series of models in which each factor was excluded while other factors remained in the model. This test indicated which factor in particular accounted for the observed age differences. Last, we examined the interaction between age and gender because findings from previous studies suggest that age differences in relationships may be stronger among women than men. For easier interpretation, we divided the continuous age variable by 10 and centered at the sample mean. Thus, regression coefficients for age indicate the corresponding change in a social interaction outcome for a 10-year age deviation from the sample's mean age (i.e., 49 years old).

Results

Preliminary Analyses

At the individual level, participants reported, on average, 2.4 social interactions at each momentary assessment (that is, approximately 12 social interactions per day). In terms of partner type, participants reported that 45% of their most recent social interactions were with one or more family members, 25% were with friends and 30% were with peripheral relationship partners. In general, participants rated their daily social interactions as high in positivity and low in negativity (positivity: $M = 5.18$, $SD = 0.79$; negativity: $M = 1.93$, $SD = 0.77$ on a 7-point scale). Moreover, 67% of the total variance of interaction frequency, 71% of interaction positivity and 75% of interaction negativity occurred at the within-person level, indicating that social interaction frequency and quality varied significantly from day-to-day and moment-to-moment within a person. In addition, the average score of social interaction diversity was 0.48 ($SD = 0.17$, $Range = 0 – 0.76$), suggesting substantial variability or diversity of interaction partners within a person and between persons. In Figure

1, we further divide the sample into three age groups to show the social interaction characteristics for each age group: younger adults (ages 20 to 39), middle-aged adults (ages 40 to 59), and older adults (ages 60 to 79). In the analyses below, however, we used the continuous age variable to test our hypotheses.

As shown in Table 1, bivariate correlations indicated that older age, higher education, being employed, being married, having children and not living alone were associated with more frequent daily social interactions with all types of partners. Younger age, being female, being non-White, being employed, having children, and not living alone were associated with interacting with more diverse partners. In terms of interaction quality, being female and having children were associated with higher social interaction quality (higher positivity and lower negativity).

Age Differences in Social Interaction Frequency

To test age differences in the frequency of daily social interactions, we examined linear and quadratic age effects on the frequency of total social interactions with all types of partners. As shown in Table 2 (Model 1), the fixed linear age effect on the mean level of frequency of total social interactions was significant, indicating that older adults reported more frequent total social interactions than young and middle-aged adults. This linear age effect was no longer significant after adjusting for a set of contextual factors (Model 2), suggesting that the included contextual factors were able to explain the higher level of total social interactions frequency among older adults. Among these covariates, being employed and married were significantly related to more frequent total social interactions. Further analyses revealed that the coefficient of age effect changed most dramatically (i.e., became significantly) if marriage status was excluded while other factors remained in the model. Given that older age was also significantly associated with being married (point biserial correlation $r = .39$, $p < .000$, Table 1), the observed higher frequency of total interactions among older adults was likely due to the higher prevalence of marriage with older age.

We then tested age differences in frequency of daily interaction with family, friend and peripheral partners respectively. Older age was associated with more frequent daily interactions with family and less frequent interactions with peripheral partners, but was not associated with frequency of interactions with friends (Model 1). These significant age effects, however, became non-significant after controlling for contextual factors (Model 2). Among all these factors, being married, having children and not living alone were associated with more frequent interactions with family members whereas employment and not having children were associated with more frequent interactions with peripheral partners. Further inspection of the regression coefficients in a series of models in which each factor was excluded while other factors remained in the model suggested that higher prevalence of having children among older adults (point biserial correlation $r = .14$, $p = .072$, Table 1) accounted for their higher frequency of interacting with family and the lower frequency of interacting with peripheral partners.

Finally, we explored age differences in the intraindividual variability of social interaction frequency and found that older age was associated with more intraindividual variability in

the frequency of all interactions but less intraindividual variability in the frequency of interacting with peripheral partners (Table 2).

Age Differences in Social Interaction Partner Type and Diversity

In order to examine whether older adults are more likely to interact with family and friends rather than peripheral partners, multinomial logistic models were used to examine the effects of age (linear and quadratic) on the likelihood of interacting with different type of partner. This analysis allowed us to explicitly compare the likelihood of interacting with one type of partner versus another type of partner on a given occasion across ages. As shown in Table 3, taking the likelihood of interacting with peripheral relationship partners as the reference, older age was associated with higher likelihood to interact with family or friends (odds ratio was 1.2 for family vs. peripheral partners and 1.15 for friends vs. peripheral partners, Model 1), supporting our hypothesis. However, these age effects became non-significant after controlling for contextual factors (Model 2). Examining all the covariates revealed that having children and not living alone were associated with higher likelihood of interacting with family members versus peripheral relationship partners; and being White, living alone and being not married were associated with higher likelihood of interacting with friends versus peripheral relationship partners. Further inspection of the regression coefficients in a series of models in which each factor was excluded while other factors remained in the model revealed that higher prevalence of having children among older adults (point biserial correlation r =.14, p =.072, Table 1) particularly accounted for their higher likelihood of interacting with family or friends versus peripheral relationships. Finally, there were no age differences in the likelihood of interacting with family versus friends before or after controlling for contextual factors.

We also examined age differences in the intraindividual variability of partner type by predicting the entropy index of interaction partner diversity from age. We found a significant linear age effect (b = −0.02, p = .036) suggesting lower intraindividual variability or diversity of partners among older adults than younger adults, as expected. This age effect remained after accounting for contextual factors.

Age Differences in Social Interaction Quality

To test age differences in the quality of daily social interactions, the linear and quadratic effects of age on participants' positive and negative ratings of their most recent social interaction were examined.

Positivity of social interactions.—As shown in Table 4, age had a significant quadratic effect and non-significant linear effect on the positivity of social interactions in the bivariate model (Model 1). Including contextual factors did not change this finding (Model 2). As depicted in Figure 2A, the pattern of age differences in positivity of daily social interactions is U-shaped with elevated levels of positivity in both young and old adults and relatively lower levels of positivity during middle age. Adults around age 50 had the least positive daily social interactions among people from all age groups, contrary to our hypothesis that interactions would be more positive for older ages. Among all other covariates, only gender had a significant effect on the positivity of social interactions, indicating that women rated

their daily social interactions as more pleasant compared with men. We also found that gender significantly moderated the quadratic age effect (gender × age ^{2}: $b = .09$, $p = .044$). Further analyses revealed no age difference in the positivity of social interactions for men (quadratic age effect: $b = .002$, $p = .955$, linear effect: $b = .01$, $p = .900$) but a significant quadratic age effect on positivity for women (quadratic age effect: $b = .10$, $p = .001$, linear effect: $b = -.06$, $p = .328$). Specifically, positivity of daily social interactions declined from young adulthood until middle age and then increased again among women.

Negativity of social interactions.—As shown in Table 4, the results from Model 1 revealed small but statistically significant quadratic and linear effects of age on the negativity of daily social interactions. These age effects became even more pronounced after including contextual factors (Model 2). As depicted in Figure 2B, negative ratings of daily social interactions increased slightly from young adulthood to middle age, and declined significantly from middle age to older age. In other words, older adults rated their daily social interactions as the least negative among people from all age groups, consistent with our hypothesis. Gender had a significant effect, indicating that women rated their daily social interactions as less negative compared with men. White participants rated daily social interactions as more negative than did non-White participants. We found no significant interactive effect of age and gender on the negative ratings of daily social interactions.

We further explored whether age differences in the quality of social interactions (positivity and negativity) were moderated by partner type (family, friends or others). The analyses revealed no moderation effects of partner type on age differences in either the positivity or negativity of daily social interactions, suggesting that age differences in the quality of interactions did not depend on the type of partner. Finally, age was related to lower intraindividual variability of social interaction positivity and negativity (Table 4), suggesting that the ratings of social interaction quality were more stable among older adults than young and middle-aged adults, supporting our prediction.

Discussion

The current study revealed a more nuanced picture of age-related variation in real-time social interactions than could be captured by global retrospective measures in past research. Using repeated momentary assessments from a community-dwelling sample, we examined age differences in the general levels and within-person variation of several important social interaction characteristics. Consistent with lifespan theories and previous research (Carstensen, 1992; Wrzus et al., 2013), our results suggest that older age is associated with more frequent daily interactions with family members and less frequent interactions with peripheral partners. In addition, older adults were more likely to interact with family or friends than peripheral partners in daily life. However, we found that older age was associated with higher total social interaction frequency, contrary to our hypothesis. Also, age was not associated with the frequency of interacting with friends, inconsistent with previous longitudinal studies (Carstensen, 1992; Kalmijin, 2012). Regarding interaction quality, we found that the pattern of age differences in the positivity of daily social interactions was U-shaped with elevated levels of positivity in both young and old adults and relatively lower levels of positivity during midlife. Although these age patterns did not

support our hypothesis, they were in line with previous findings on marital relationships that midlife dips in marital satisfaction relative to both younger and older ages (Gilford & Bengtson, 1979; Rollins, 1989). In addition, older adults reported the lowest level of negativity of social interactions, supporting our hypothesis. Finally, our analyses on intraindividual variability found evidence to support predicted age-related associations in the intraindividual variability of the interaction frequency with peripheral partners, diversity of interaction partners, and interaction quality (both positivity and negativity), suggesting that social interaction characteristics varied less from day-to-day and moment-to-moment for older adults than younger adults.

The second major contribution of our study is that we showed that contextual factors can shape daily social interactions across ages, as suggested by Social Convoy Model (Antonucci et al., 2004; Kahn & Antonucci, 1980). Our findings suggest that, in general, the contextual factors examined in our study including gender, race, education, employment status, marriage, parenthood and living arrangement could account for the observed age differences in the structural aspects of social interactions, such as the frequency and partner types, but could not explain age differences in the social interaction quality. Specifically, age was no longer significantly associated with social interaction frequency or partner type after controlling for contextual factors. Further analyses revealed that being married and having children, both common circumstances at older ages, explained older adults' higher likelihood of interacting with family members versus peripheral partners in their daily life compared with young and middle-aged adults. Additionally, the observed higher frequency of total interactions among older adults in our study was most likely driven by the higher prevalence of marriage among older adults, which increases their opportunities to interact with spouses, in-laws and other relatives in daily life. A previous longitudinal study provided evidence that frequency of contact with relatives increased after marriage whereas frequency of contact with acquaintances decreased after becoming parents (Kalmijn, 2012). Our findings are also in line with a recent meta-analysis of 277 studies in which the researchers concluded that age-related life events accompany and perhaps even initiate the age-graded path of social network changes (Wrzus et al. 2013).

We did not find a significant association between age and daily interaction frequency with friends, inconsistent with previous longitudinal studies showing a decline in the frequency of contact with friends with aging (Carstensen, 1992; Shaw et al., 2007). Perhaps the older participants in our study were able to recall more interactions with friends in the past two or three hours compared with the older adults in previous studies who were usually asked to recall their experience over longer time periods (e.g., in the past weeks or months). Future studies with larger samples are needed to examine whether the absence of age differences in the frequency of interacting with friends in our study reflected a true phenomenon, or was due to type II error.

Our findings on social interaction quality were not entirely consistent with the hypothesis that older adults would have higher quality social interactions (i.e., higher positivity and lower negativity) than young and middle-aged adults. Instead, we found that the relationship between age and social interaction quality was nonlinear with middle-aged women reporting the lowest level of positivity in social interactions among all age groups. Additionally, older

adults rated their social interactions as less negative than young and middle-aged adults, with the latter two groups not differing from each other. Further analyses indicated that these age-graded patterns of social interaction quality were not moderated by partner type, suggesting that the age differences in interaction quality were not due to older adults' preferences of interacting with close versus peripheral partners as suggested by SST. However, other contextual factors included in our study did not account for these age differences either. One possible explanation is that other factors that were not assessed in our study, such as the menopause transition, elder-caregiving responsibilities and stress, work-family conflict, and role overload, contribute to the less positive daily social interactions during midlife for women (Almeida, 2005; Story et al., 2007). Past research has also showed a similar U-shaped pattern for life satisfaction or marital satisfaction with midlife at the bottom (Bradbury, Fincham, & Beach, 2000; Lachman, Teshale, & Agrigoroaei, 2015; Tucker & Aron, 1993), and attributed it to transitions such as childbearing, parenthood, and the empty nest (Rollins, 1989; VanLaningham, Johnson, & Amato, 2001). On the other hand, age-related reduction in interaction negativity could be due to age-related improvement in emotion regulation skills (Charles et al., 2009) and social expertise (Blanchard-Fields, 2007), or the more benevolent social environment of older adults (Luong et al., 2011).

Finally, our finding of age differences in the intraindividual variability of social interactions extends the literature on social relationships and aging by showing how short-time period fluctuations in social interactions could differ across ages. Consistent with past work showing age-related decreases in intraindividual variability of emotion (Rocke, Li, & Smith, 2009; Brose, Scheibe, & Schmiedek, 2013), we found that older adults reported lower intraindividual variability in interaction frequency with peripheral partners, interaction partner types, and interaction positivity and negativity than did young and middle-aged adults. The lower intraindividual variability of social interactions among older adults may be due to improvements in their ability to regulate and optimize daily experience (Carstensen et al., 1992; Charles, 2010), or to their less varied environment and fewer daily stressors (Koffer & Ram, 2015). Future research would benefit from further examination of the extent to which age differences in the intraindividual variability of social interactions are driven by a person's characteristics or capacities, quickly changing events or contexts, or person-context transactions that could result in dynamic processes such as adaptation, differentiation, and learning (Koffer & Ram, 2015).

One finding that was inconsistent with previous studies was the age-related increase in the intraindividual variability of total social interaction frequency. It is possible that, compared with young and middle-aged adults, although older adults' overall social network size reduced because of the decreased number of friends or peripheral partners (Shaw et al., 2007; Wrzus et al., 2013), they may have more freedom and flexibility to decide how much and how often they would like to interact with remaining partners from day-to-day or from moment-to-moment. It is also possible that older participants were more vulnerable to memory errors when asked to recall the exact number of social interactions in the past two or three hours (instead of reporting on the most recent interaction) than their younger counterparts, which leads to the greater variability. Thus, future research is needed to replicate and explain this finding.

In sum, our study provides a more sensitive and ecologically valid examination of daily social interactions and advances our understanding of daily social interactions across the lifespan. More importantly, our findings point out that a better understanding of the variations of daily social interactions requires explicit attention to life stage and associated changes in social goals, regulatory skills, roles and responsibilities as well as contexts. Therefore, it is crucial to integrate different theoretical perspectives on social relationship development and aging in future research.

Limitations and Future Directions

There are several unanswered questions that present promising avenues for future research. First, the data in this study were cross-sectional in nature and permit only age group comparisons. In other words, the age and cohort effects cannot be clearly separated in this study. In order to truly evaluate the age or developmental effects in social interactions, longitudinal data across the lifespan is needed in future research, perhaps using measurement burst designs (see Smyth, Juth, Ma, & Sliwinski, 2017). Second, the older adults who chose to participate in the current study may have reflected the best functional and most social group of their cohort, which could have painted an overly favorable view of age differences in social interactions. Third, our measurement of social interactions did not request or assess the duration of each reported interaction. It is likely that social interactions that have lasted for a certain period of time (e.g., 10 min) would be more meaningful and influential for individuals compared with short encounters. We also focused on capturing the most recent social interaction at each sampling moment; as a result, we missed other social interactions that may have occurred. In addition, we defined social interaction as “talking to someone in person, by phone, or online”, and thus our results did not differentiate interactions via distinct channels. It is a promising route for future research to examine how different types of social interactions vary across ages and whether different types of social interactions have distinct features and functions for people from different ages. Moreover, we did not directly examine the social motives, emotional regulatory experiences and skills, or other psychological variables as potential mechanisms to account for age differences in social interactions. Future research would benefit from directly comparing the effects of psychological versus contextual factors on explaining the age differences in social interactions.

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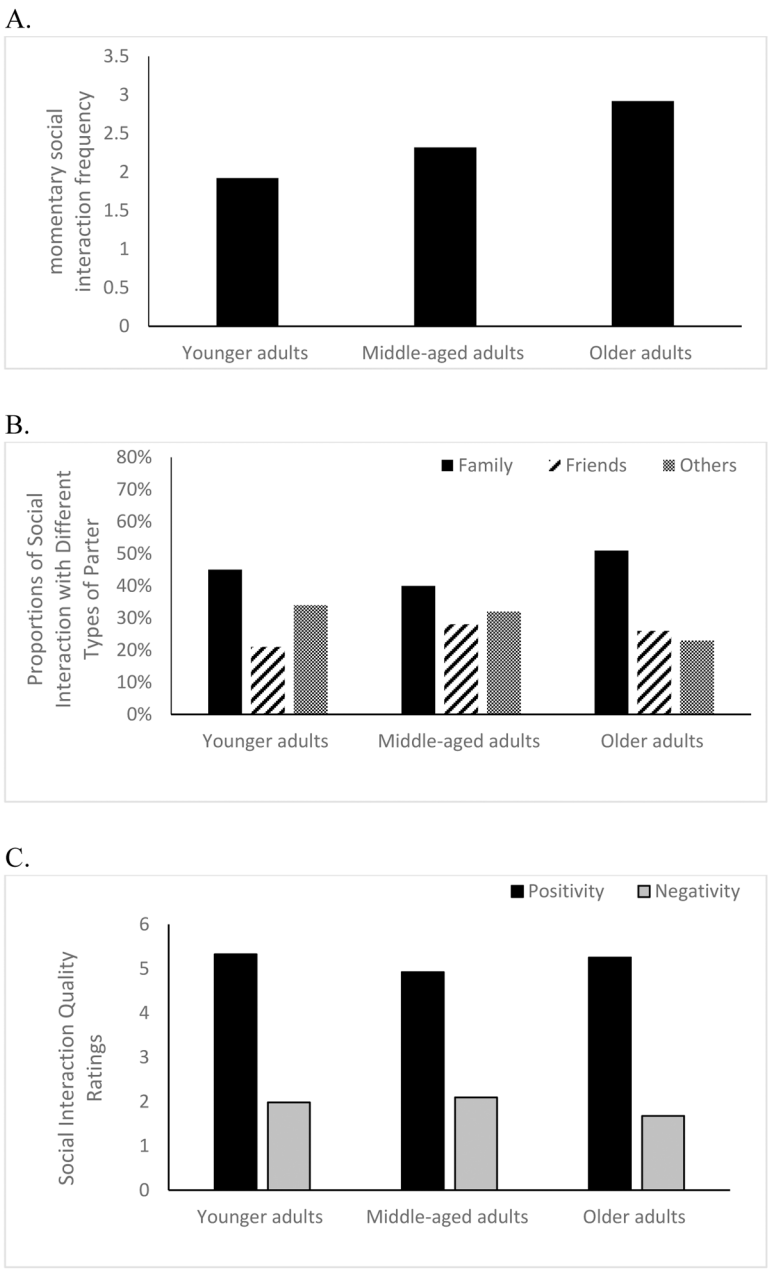
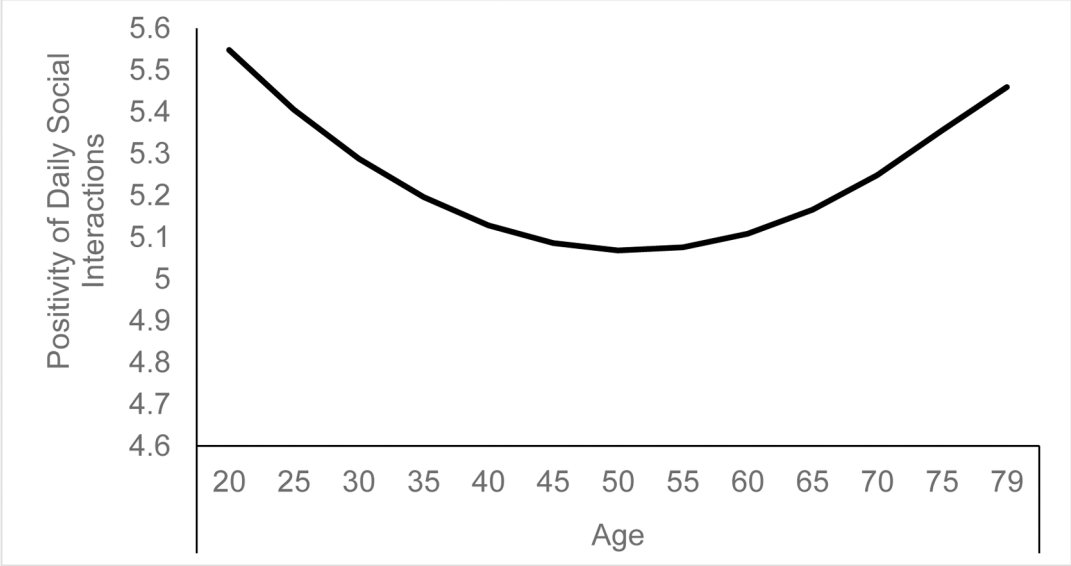


Figure 1.

Description of social interaction characteristics across different age groups. (A) Interaction frequency. (B) Interaction partner types. (C) Interaction quality. N=173 for the whole sample. N = 56 for young adults (20 to 39 years old); N = 61 for middle-age adults (40 to 59 years old); N = 56 for older adults (60 to 79 years old).

A.



B.

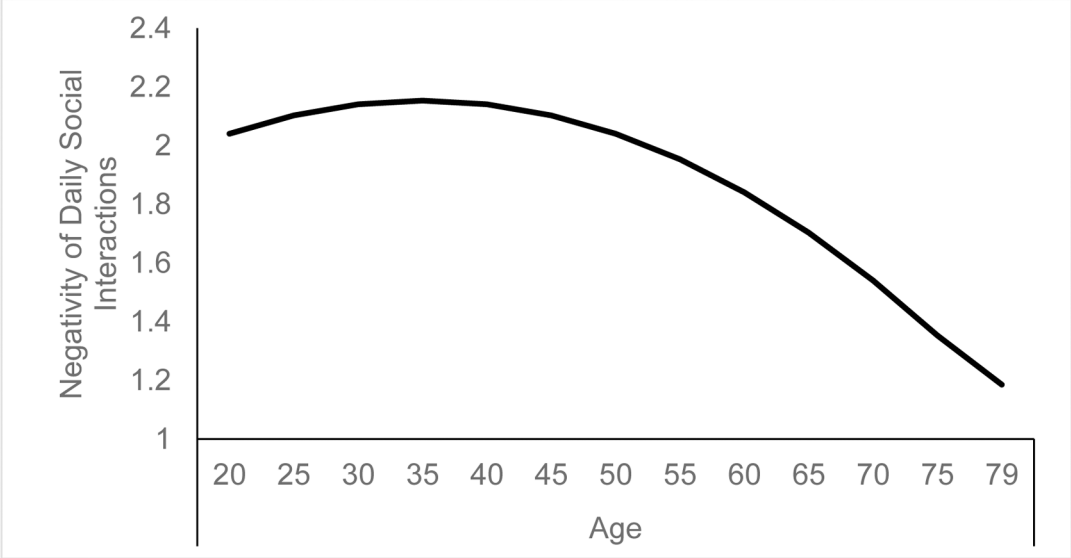


Figure 2.

Age difference patterns for (A) positive ratings of social interactions, (B) negative ratings of social interactions after controlling for all covariates.

Table 1

Correlations Among Study Variables at Person Level

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	1													
2. Gender	.01	1												
3. White	.33**	.06	1											
4. Education	.19*	−.06	.31**	1										
5. Employed	−.07	.08	.08	.27**	1									
6. Married	.39**	.20*	.34**	.32**	.07	1								
7. Children	.14+	.27**	−.04	.02	.13+	.19*	1							
8. Living Alone	.05	−.21**	−.30**	−.25**	−.09	−.44**	−.23*	1						
9. Freq. of Total SI	.18*	.14	.09	.20**	.36**	.28**	.27**	−.17*	1					
10.Freq. of Family SI	.26**	.19**	.37**	.34**	.01	.49**	.36**	−.55**	.21**	1				
11. Freq. of Friend SI	.14	−.09	.06	.003	.02	−.27**	−.20**	.35**	−.01	−.31**	1			
12. Freq. of Peripheral SI	−.12	.02	−.07	.16*	.32**	−.03	−.12	.06	.28**	−.18*	−.06	1		
13. Diversity of SI	−.16*	.28**	−.20**	−.07	.21**	.08	.50**	−.25**	.34**	.10	−.29**	.24**	1	
14. Positivity of SI	−.05	.23**	−.05	.10	.15*	.06	.20**	−.12	.14	.14	−.07	−.05	.26**	1
15. Negativity of SI	−.16*	−.18*	.01	−.14	−.01	−.11	−.21**	.10	−.05	−.24**	.12	.07	−.10	−.49**

Note. SI-Social Interaction. Gender (0 = male, 1 = female), White (0 = non-White, 1 = White), Education (0 = high school or less, 1 = college degree or graduate degree), Employed (0 = not employed, 1 = currently employed), Married (0 = not married, 1 = currently married), Children (0=no children, 1=having children), Living Alone (0 = live with spouse, family members, or others, 1 = live alone). Pearson product-moment correlation was calculated between two continuous variables and biserial or point biserial correlation was calculated between two binary variables or a binary variable and a continuous variable.

+ $p<.10$.

* $p<.05$;

** $p<.01$.

Table 2

Multilevel Regression Models Predicting Frequency of Daily Social Interactions

	Frequency of Social Interaction with ALL partners		Frequency of Social Interactions with Family		Frequency of Social Interacting with Friends		Frequency of Social Interacting with Other Peripheral Partners	
	Model 1	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**
	b(SE)	*b(SE)*	*b(SE)*	*b(SE)*	*b(SE)*	*b(SE)*	*b(SE)*	*b(SE)*
Fixed Effects								
Intercept	2.37*** (0.18)	1.63*** (0.49)	1.29*** (0.13)	1.07*** (0.28)	0.64*** (0.08)	0.41 (0.22)	0.79*** (0.07)	1.07*** (0.21)
Age (in decades)	0.18** (0.07)	0.10 (0.10)	0.15** (0.05)	−0.01 (0.06)	0.05 (0.03)	0.05 (0.05)	−0.07* (0.03)	0.002 (0.04)
Age^2	0.01 (0.05)	0.001 (0.05)	0.03 (0.03)	0.01 (0.03)	0.001 (0.02)	−0.001 (0.02)	−0.01 (0.02)	−0.02 (0.01)
Gender		0.31 (0.26)		0.10 (0.15)		−0.01 (0.11)		0.06 (0.10)
White		−0.32 (0.29)		0.20 (0.16)		0.30* (0.13)		−0.17 (0.12)
Education		0.18 (0.30)		0.31 (0.19)		−0.02 (0.14)		0.17 (0.13)
Employed		1.09*** (0.26)		−0.20 (0.15)		0.09 (0.12)		0.31** (0.11)
Married		1.08** (0.38)		0.48* (0.22)		−0.36* (0.17)		−0.06 (0.15)
Children		−0.02 (0.32)		0.56** (0.19)		−0.15 (0.15)		-0.45** (0.14)
Living Alone		0.04 (0.32)		−0.99*** (0.18)		0.58*** (0.15)		0.10 (0.13)
Random Effects on Level-1 Residual								
Age (in decades)	0.07*** (0.01)	0.07** (0.01)	−0.02 (0.03)	−0.01 (0.03)	0.04 (0.03)	0.01 (0.03)	−0.15*** (0.03)	−0.16*** (0.03)
Age^2	−0.001 (0.01)	−0.01 (0.01)	0.01 (0.02)	0.01 (0.02)	0.02 (0.02)	0.01 (0.02)	−0.01 (0.02)	−0.02 (0.02)
Residual	5.11*** (0.15)	5.31*** (0.18)	0.92*** (0.07)	0.95** (0.08)	0.46*** (0.03)	0.52*** (0.04)	0.76*** (0.06)	0.87*** (0.07)

Note. Gender (0 = male, 1 = female), White (0 = non-White, 1 = White), Education (0 = high school or less, 1 = college degree or graduate degree), Employed (0 = not employed, 1 = currently employed), Married (0 = not married, 1 = currently married), Children (0=no children, 1=having children), Living Alone (0 = live with spouse, family members, or others, 1 = live alone).

* p<.05.

** p<.01.

*** p<.001.

Table 3

Multinomial Regression Models Predicting Probability of Interacting with Different Types of Partners

	Probability of Interacting with Family (vs. Other peripheral partners)[a]				Probability of Interacting with Friends (vs. Other peripheral partners)[a]				Probability of Interacting with Family (vs. Friends)[b]			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	b(SE)	*OR*	*b(SE)*	*OR*	*b(SE)*	*OR*	*b(SE)*	*OR*	*b(SE)*	*OR*	*b(SE)*	*OR*
Fixed Effects												
Intercept	0.40 ** (0.14)		−0.11 (0.46)		−0.38 ** (0.12)		−1.06 * (0.46)		0.66 *** (0.16)		0.75 (0.52)	
Age (in decades)	0.18 * (0.08)	1.20	−0.02 (0.10)	0.98	0.14 * (0.07)	1.15	0.10 (0.10)	1.10	0.03 (0.09)	1.03	−0.14 (0.11)	0.87
Gender			0.04 (0.26)	1.04			−0.07 (0.26)	0.93			0.13 (0.28)	1.14
White			0.32 (0.30)	1.38			0.75 * (0.29)	2.13			−0.40 (0.33)	0.67
Education			−0.29 (0.31)	0.75			−0.15 (0.32)	0.86			−0.14 (0.35)	0.87
Employed			−0.48 (0.26)	0.62			−0.01 (0.27)	0.99			−0.36 (0.29)	0.70
Married			0.60 (0.37)	1.83			−0.89 * (0.39)	0.41			1.51 *** (0.42)	4.53
Children			1.31 ** (0.34)	3.69			0.21 (0.32)	1.24			1.06 ** (0.37)	2.89
Living Alone			−1.52 *** (0.31)	0.22			0.71 * (0.32)	2.04			−2.11 *** (0.35)	0.12

Note. OR=Odds Ratio.

[a] Other peripheral partners severed as referent group in the model.

[b] Friends severed as referent group in the model. Gender (0 = male, 1 = female), White (0 = non-White, 1 = White), Education (0 = high school or less, 1 = college degree or graduate degree), Employed (0 = not employed, 1 = currently employed), Married (0 = not married, 1 = currently married), Children (0=no children, 1=having children), Living Alone (0 = live with spouse, family members, or others, 1 = live alone).

* p<.05

** p<.01

*** p<.001.

Table 4

Multilevel Regression Models Predicting Quality of Daily Social Interactions

	Positivity of Social Interaction		Negativity of Social Interaction	
	Model 1	**Model 2**	**Model 1**	**Model 2**
	b*(SE)*	b*(SE)*	b*(SE)*	b*(SE)*
Fixed Effect				
Intercept	5.05***(0.09)	4.90***(0.25)	2.07*** (0.08)	1.70***(0.24)
Age (in decades)	−0.03(0.03)	−0.02 (0.05)	−0.06^{+} (0.03)	−0.13* (0.05)
Age2	0.05^{*m}(0.02)	0.05^{*m} (0.02)	−0.05* (0.02)	−0.05* (0.02)
Gender		0.31** (0.13)		−0.28* (0.13)
White		−0.21 (0.15)		0.48** (0.14)
Education		0.12 (0.16)		−0.16 (0.15)
Employed		0.16 (0.13)		0.06 (0.13)
Married		−0.02 (0.19)		0.13 (0.18)
Children		0.11 (0.17)		0.09 (0.16)
Living Alone		−0.10 (0.16)		0.24 (0.15)
Random Effect on Level-1 Residual				
Age (in decades)	−0.09***(0.01)	−0.10***(0.01)	−0.08***(0.01)	−0.06** (0.01)
Age2	0.01 (0.01)	0.005 (0.01)	0.01 (0.01)	−0.001 (0.01)
Residual	1.17***(0.04)	1.19***(0.05)	1.35***(0.05)	1.32***(0.05)

Note. Gender (0 = male, 1 = female), White (0 = non-White, 1 = White), Education (0 = high school or less,

1 = college degree or graduate degree), Employed (0 = not employed, 1 = currently employed), Married (0 = not married, 1 = currently married), Children (0=no children, 1=having children), Living Alone (0 = live with spouse, family members, or others, 1 = live alone).

m, Significant gender moderation.

$^{+}$p<.10

*p<.05.

**p<.01.

***p<.001.