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Variety Is the Spice of Late Life: Social Integration and Daily Activity

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Abstract

Objectives: Social integration (involvement with a diverse array of social ties) has been linked to positive outcomes including better physical health. Research has not investigated whether encounters with diverse social ties enhance individuals' daily behaviors. The objectives of this study were to assess whether social ties connect individuals to more diverse daily behaviors, physical activity, and nonsedentary time as well as more positive mood.

Method: Older adults (aged 65+, *n* = 313) provided information about their 10 closest social ties. Then they completed ecological momentary assessment (EMA) surveys every 3 hr for 5–6 days where they reported on social encounters and behaviors. They also wore Actical accelerometers to objectively measure physical activity.

Results: Multilevel models revealed that encounters with a greater variety of social ties was associated with engaging in a greater variety of behaviors, more objectively measured physical activity, and a smaller proportion of time spent sedentary. Encounters with weak ties/peripheral social ties accounted for this increased activity (compared to being alone or with close friends or family). Moreover, involvement with diverse ties or diverse behaviors was associated with better mood.

Discussion: Findings are discussed in terms of social engagement theory, network diversity, and the benefits of weak ties.

Keywords: Accelerometer, Actical, Actigraphy, Ecological momentary assessment, EMA

A vast literature links involvement with a variety of social ties to better well-being in late life (Holt-Lunstad, Smith, & Layton, 2010; Thomas, 2012). Older adults who have more diverse networks (i.e., connections to close family and friends, acquaintances, and community members) have better physical and mental health (e.g., Fiori, Antonucci, & Cortina, 2006; Fiori & Jager, 2012; Litwin & Shiovitz-Ezra, 2006). Possible mechanisms to explain this link have included social support (Gleason & Iida, 2015; Uchino, 2009), health behaviors (e.g., eating well, doctors' visits, Pietromonaco & Collins, 2017;

Umberson & Montez, 2010), and buffering emotional upheavals under stress (Cohen & Lemay, 2007; Wethington & Kessler, 1986). These mechanisms, however, are typically activated by close friends and family members (see review by Rook & Charles, 2017), and do not explain potential benefits of a more diverse network that includes peripheral social ties (i.e., individuals outside the network of close social ties).

It is possible that different relationships foster different types of activities that contribute to well-being. Some researchers contend that the addition of weak/peripheral

ties creates diverse networks that are more beneficial than networks comprised solely of close family or friends (Fiori, Smith, & Antonucci, 2007; Litwin & Shiovitz-Ezra, 2006). They argue that weak ties provide distinct resources or social capital, including a wider range of activities (Fingerman, 2009; Granovetter, 1973). Diverse behaviors, in turn, may lead to greater levels of physical activity and enhanced well-being.

The few studies addressing these issues have relied predominantly on global self-reports and have found that larger, more varied social networks are associated with greater number of recent behaviors (Litwin & Stoeckel, 2016) and more physical activity (Litwin, 2003). These aggregated data, however, do not specify how actual social interactions correspond to daily behaviors or physical activity. The current study used assessments throughout the day to examine whether individuals engage in more daily behaviors (e.g., exercising, volunteering, eating, visiting) and greater physical activity when they interact with a wider variety of social ties. This study addressed the role that weak or peripheral social ties play in these behaviors (compared with close ties), given their relatively unexplored role in research.

Social Integration, Behaviors, and Physical Activity

Diversity of Behaviors

Social integration and social engagement theories posit that diverse social ties confer benefits by connecting individuals to resources and activities (Berkman, Glass, Brissette, & Seeman, 2000; Thomas, 2012). Interacting with diverse people entails engaging in diverse behaviors (Baker, Cahalin, Gerst, & Burr, 2005; Fingerman, Huo, Ng, & Zarit, in press; Litwin & Stoeckel, 2016). By definition, socially integrated individuals participate in diverse behaviors such as attending church or doing volunteer work (e.g., Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997; Thomas, 2012). Thus, we hypothesized that involvement with a greater variety of social ties would be associated with a greater variety of behaviors throughout the day (compared with when older adults are alone or with a limited set of social ties).

Physical Activity and Sedentary Behavior

We also examined whether increased physical activity helps to explain why a greater diversity of social ties is related to better health. In several studies using self-report data, Litwin, Schwartz, and Damri (2017) found that both physical activity and diverse social networks predicted cognitive functioning 2 years later. Liao, Intille, and Dunton (2015) used ecological momentary assessments to examine physical activity and sedentary behaviors that co-occurred with social involvement among adults. They found that social involvement was associated with increased physical activity. Researchers have argued that a greater proportion of time being sedentary represents a health risk unrelated to activity levels when not sedentary (Healy, Matthews, Dunstan, Winkler, & Owen, 2011; Wilmot et al., 2012). Even low levels of physical activity that prevent sedentary periods have positive implications for health (Katzmarzyk, Church, Craig, & Bouchard, 2009).

Close Versus Peripheral Ties

Peripheral ties may also promote greater physical activity, even more so than close ties. Theory suggests that peripheral or weak ties expose individuals to novel behaviors and activities (e.g., leisure, volunteer work) not experienced with closer ties (Fingerman, 2009). Interacting with peripheral ties often necessitates leaving the home, or at least getting out of one's chair to answer the door. In contrast, people may engage in patterned habits of behavior with their closest ties that often focus on being at home and remaining sedentary.

Diverse Social Ties, Diverse Behaviors, Physical Activity, and Mood

Encountering a greater diversity of social ties may be related to more positive mood and less negative mood throughout the day. Several studies suggest that engaging in a variety of behaviors is related to higher levels of well-being. For example, data from the National Survey of Daily Experiences revealed that older adults (aged 60–74) who reported a greater diversity of daily behaviors reported better psychological well-being (Lee et al., 2018). Similarly, Baker and colleagues (2005) asked about volunteering, providing help, and engaging in do-it-yourself activities and found that diversity in behaviors was associated with well-being. These studies relied on aggregate self-reports of limited behaviors, but we expected a similar pattern of co-occurring social interactions and behaviors throughout the day.

Close Versus Peripheral Ties

We investigated whether encounters with peripheral ties instigate better mood. In one study, college students and community-dwelling adults tracked their social engagement throughout the day and reported their sense of belongingness and well-being at the end of the day (Sandstrom & Dunn, 2014). For college students, greater engagement with peripheral ties was associated with increased psychological well-being. For community-dwelling adults, involvement with peripheral ties was associated with increased feelings of belonging, whereas involvement with close ties was associated with better well-being.

In sum, theories of social integration assume that high social engagement is inherently linked with engagement in diverse behaviors and activities. Prior studies also suggest involvement with diverse social partners serves as a catalyst

to increased physical activity (and diminished time spent sedentary) across months or years. Yet, there are no data to link social engagement with diverse behaviors or physical activity co-occurring in shorter time periods throughout the day. Moreover, associations have been documented between social engagement and overall well-being over long periods of time, but not in the moment. Finally, theory also suggests that close and peripheral ties may have disparate influences on behaviors and activity, but research rarely compares these two types of relationships. The current study addresses these gaps in the literature.

The Current Study

We used ecological momentary assessments (EMA) to examine social encounters, behaviors, physical activity, and mood throughout the day. Global assessments necessarily involve between-person comparisons of more active and less active individuals. By examining within-person fluctuations throughout the day, we could ask whether individuals engaged in more diverse behaviors were happier when encountering diverse social ties than when they were alone or with a limited set of ties.

This study included a broader range of behaviors (i.e., 14 different sets of behaviors) than prior studies (e.g., Baker et al., 2005; Lee et al., 2018). Prior research suggests older adults are able to accurately remember and self-report their recent activities (Baker et al., 2005; Litwin & Stoeckel, 2016). Accelerometers/actigraphs provided objective measures of physical activity and proportion of time sedentary.

We also controlled for several factors associated with social networks or behaviors in our models: age, gender, marital status, education, racial/ethnic status, and global health. With age, researchers have documented changes in social network configurations (e.g., Charles & Carstensen, 2010), daily social contacts, and activity (Cornwell, 2011). Women are more likely to be widowed in late life, but have larger social networks than men (Antonucci, Akiyama, & Takahashi, 2010). Compared with less educated adults, better-educated adults report a greater variety of social ties (Ajrouch, Blandon, & Antonucci, 2005). Researchers have observed diverse patterns with regard to racial and ethnic differences in ties to family and friends in late life (Conway, Magai, Jones, Fiori, & Gillespie, 2013; Sarkisian & Gerstel, 2004). We adjusted for global physical health, to account for between person differences in our models.

Method

The Daily Experiences and Well-being Study (DEWS) involved adults aged 65 and older residing in the greater Austin Texas Metropolitan Statistical Area. Participants were recruited via listed landline samples with matching addresses because sampling for older adults in 2016 benefited from use of landlines (Kennedy, McGeeney, & Keeter, 2016). The interview response rate for the study was 75%.

Oversampling in high-density minority neighborhoods and lower SES neighborhoods resulted in a racially and ethnically diverse sample and the full range of SES (Table 1).

Participants first completed an approximately 2-hr in-person interview (referred to as the "global interview"), including questions about close social ties and participant background information. Participants then completed a 5- to 6-day intensive data collection across 3 weekdays and 2 weekend days. Variability in days reflected when interviewers could return to collect equipment. The intensive data collection included Ecological Momentary Assessments (EMA) every 3 hr while awake; participants reported their social encounters and behaviors. Participants received $50 for the global interview and $100 for the intensive data.

Participants answered EMA questionnaires on a hand-held Android device provided by the study; participants unfamiliar with the technology received training and follow-up technical support. Participants completed $M = 20.01$ assessments (total assessments $n = 6,262$). Participants wore an Actical accelerometer to objectively measure physical activity and sedentary behavior during the 5- to 6-day period.

This study included 313 (from a total of 333) participants who completed ecological momentary surveys and who wore the Actical. A power analysis indicated that a sample of 300 was more than adequate for the research questions (see Supplementary Appendix 1 for details). Compared to the other 20 participants, the 313 participants were less likely to identify as an ethnic or racial minority ($t = 2.26$, $p < .05$). They did not differ on other demographic characteristics or reports of social relationships. The current study included more than 30% older adults who identified as racial or ethnic minority and 15% of participants had completed high school or less education. Notably, other studies of older adults using diary methods (e.g., Birditt, Fingerman, & Almeida, 2005; Meija & Hooker, 2015) or ecological assessments (e.g., Ram et al., 2014) included primarily White, well-educated older adults.

Nevertheless, the study was better educated than the general population; 56% of our participants had a Bachelor's degree, compared with 45% of adults over age 65 in Austin (U.S. Census Bureau, 2017). Moreover, participants were skewed on the personality trait conscientiousness, averaging $M = 4.04$ ($SD = 0.57$) on a 5-item scale with responses that ranged from 1 = *not at all* to 5 = *a great deal*, compared to $M = 3.39$ ($SD = 0.45$) with a nationally representative sample of older adults from the Health and Retirement Study (Stephan, Sutin, & Terracciano, 2014).

The Global Interview

Participants reported their age, gender, educational attainment (ranging from 1 = *no formal education* to 8 = *advanced degree*), marital status (1 = *married*, 0 = *not married*), and ethnicity and race (recoded as 1 = *ethnic or racial minority*, 0 = *non-Hispanic white*). Participants rated their health on a scale from 1 = *poor* to 5 = *excellent* (Idler & Kasl, 1991).

Table 1. Descriptive Information for Participants and Daily Experiences

Characteristics	Participants (*n* = 313)		
	M	*SD*	Range
Age	73.94	6.38	65–90
Education[a]	5.88	1.61	1–8
Health[b]	3.56	1.02	1–5
Every 3 hr			
Social encounters diversity[c]	1.96	0.76	0–19
Had encounter with close tie[d]	0.79	0.26	0–1
Had encounter with peripheral tie[e]	0.51	0.22	0–1
Diverse behaviors[f]	3.63	1.00	0–12
% of time being sedentary[g]	0.48	0.15	0–1
		Proportions	
Females		.56	
Married[h]		.59	
Minority[i]		.31	

[a]1 = *no formal education*, 2 = *elementary school*, 3 = *some high school*, 4 = *high school*, 5 = *some college/vocation or trade school*, 6 = *college graduate*, 7 = *post college but no additional degree*, 8 = *advanced degree*.

[b]1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *very good*, 5 = *excellent*.

[c]Averaged encounters with a diverse variety of social ties every 3 hr.

[d]Percentage of 3-hr assessments when participants had encounters with any close tie.

[e]Percentage of 3-hr assessments when participants had encounters with any not close tie.

[f]Averaged diversity of behaviors participants engaged in (e.g., eating, shopping, driving, volunteering) every 3 hr.

[g]Averaged percentage of time when participants were sedentary every 3 hr.

[h]1 = *married/remarried*, 0 = *not married*.

[i]Coded as 1 = *ethnic or racial minority*, 0 = *non-Hispanic white*.

Close ties

Participants completed the convoy model diagram to assess their close social ties, listing their close and important social ties in three concentric circles. Consistent with other studies, participants answered additional questions regarding up to 10 of their closest social ties, including how they were related (e.g., spouse, child, sibling, in-law, friend; Antonucci, Ajrouch, & Birditt, 2014). We refer to these social ties as "close ties."

Ecological Momentary Assessments

Diversity of social contacts

Every 3 hr, participants indicated whether they had contact with each of their 10 close/important social ties. Participants then indicated whether they had contact with anyone else during the prior 3 hr. If so, they answered questions including how they knew this person (e.g., acquaintance, service provider, stranger). From these responses, we generated an index of encounters with diverse social ties in the 3-hr interval, including spouse/romantic tie, child/stepchild, child-in-law, sibling, sibling-in-law, friends, grandchild/step grandchild, niece/nephew, acquaintances, service provider, stranger, formal group, informal group, etc. We coded diversity in types of social ties (e.g., spouse, children, friends), consistent with studies of social integration and network diversity (Cohen et al., 1997; Fiori et al., 2006). We did, however, include a broader range of ties than measures of social integration (e.g., Cohen et al., 1997; Thomas, 2012) given the broad range of ties participants identified in the convoy model.

Close versus peripheral ties

We coded "close tie encounter" if the participant had contact with anyone listed among their 10 convoy members in the prior 3 hr. We coded "peripheral tie encounter" if the participant had contact with anyone not listed in the convoy in the prior 3 hr. We recognize that some peripheral ties might be subjectively close (e.g., more distant friends), but we relied on those identified in the convoy model as close ties. Strangers were also classified here under peripheral ties.

Diverse behaviors

Every 3 hr, participants indicated whether they engaged in 14 sets of waking behaviors. Each set included similar behaviors (e.g., bathing/dressing/self-care behaviors; reading/puzzles/music; shopping/errands, eating). We treated television viewing as distinct from using computers or electronics. Prior studies have assessed the proportion of time individuals spent in each behavior relative to total time to generate a metric of diversity of behaviors (Lee et al., 2018). Respondent burden precluded asking the amount of time in each behavior. Instead, we used the total number of endorsed behavior sets at each 3-hr interval (Supplementary Table 1).

Physical activity assessment

Phillips Respironics Actical Zs objectively assessed physical activity. Actical or accelerometer assessment is considered the gold standard for measurement of physical activity and sedentary behavior in younger and older adults (Huisingh-Scheetz et al., 2016; Troiano, 2006). The Actical measures motion in multiple directions and calculates the intensity of physical activity. The device is waterproof, unobtrusive and similar to a standard wristwatch. Participants strapped the Actical on their wrist using a plastic hospital band for the 5- to 6-day study period. Previous research with older adults has found that a period of 3 to 4 days is considered adequate to capture daily physical activity (Huisingh-Scheetz et al., 2016; Rowe, Kemble, Robinson, & Mahar, 2007). Data from the Actical are time-stamped, and could be compared with self-report data from the EMA. Actical data are reported as activity counts and also provide an index of proportion of time spent sedentary (Huisingh-Scheetz et al., 2016; Troiano, 2006). Acticals collect continuous accelerometer data available in averages across 1 min or 1 hr intervals. We averaged data across the 3-hr reports.

Positive and negative mood

Participants rated their mood every 3 hr. Based on diary studies, participants rated 5 negative emotions (e.g., sad, bored) and 3 positive emotions (e.g., calm) on a scale from 1 = *not at all* to 5 = *a great deal)* in the prior 3 hr (Fingerman, Kim, Birditt, & Zarit, 2016; Watson, Clark, & Tellegen, 1988). We used the average for each scale, $\alpha = .73$ positive mood, and $\alpha = .72$ negative mood.

Analytic Strategy

We examined descriptive statistics for outliers and missing data. Using the continuous Actical data, we averaged the total activity counts over the 3 hr, as well as the proportion of time spent sedentary. Activity counts provide a basis for comparison of objective physical activity under different social conditions (Huisingh-Scheetz et al., 2016; Troiano, 2006). To better understand the patterns of social engagement, behaviors, and activity, we plotted a figure (Figure 1) illustrating patterns of social engagement, activity, and time sedentary throughout the day for a participant who scored near the average for daily social engagement, an approach used in studies of children to compare co-occurring activities (de Barbaro, Johnson, Forser, & Deak, 2013). We examined bivariate associations to detect potential multi-collinearity in models.

Hypothesis testing involved three-level multilevel models (3-hr time blocks, nested in days, nested in participants). The first set of models tested whether encounters with a greater diversity of social ties predicted: (a) greater diversity of behaviors, (b) higher physical activity, and (c) less time spend sedentary. We mean-centered around each person's average across the 5 days for diverse social encounters to make within-person comparisons. In addition to examine overall diversity of the social network, we also reran the models separately for number of peripheral ties and then for number of close ties with the same outcomes: diverse behaviors, physical activity and proportion of time spent sedentary. The next set of multilevel models focused on positive and negative mood every 3 hr. Encounters with
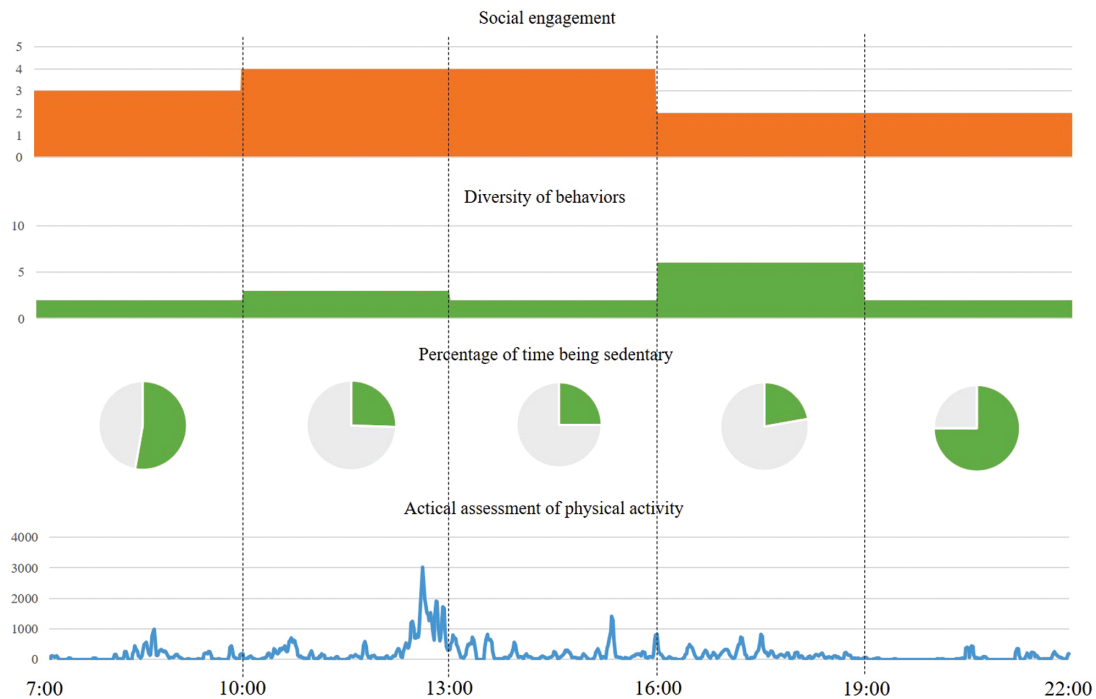
Figure 1. Illustration of daily activities in a participant with mean social integration score from 7 a.m. to 10 p.m. Orange blocks represent the number of encounters with different types of ties and green blocks represent the number of sets of behaviors this participant engaged in every 3 hr. The pies represent the percentage of time participant spent sedentary in each 3-hr block. Blue lines represent continuous activity counts assessed by the Actical.

diverse social ties and engaging in diverse behaviors were the predictors. All models adjusted for age, education, gender, marital status, race/ethnicity, and overall physical health.

Follow-up analyses examined each set of behaviors separately (e.g., TV watching, reading/puzzles, music). We also grouped the most frequent behaviors (i.e., behaviors that occurred in more than 40% of the 3-hr assessments) separately from less frequent behaviors to assure one type of behaviors did not account for findings. We broke down peripheral ties to consider strangers and acquaintances separately. We considered time of day (early morning, midday, evening) to assure that the most active period at midday did not account for findings. Further, we assessed whether the association between activity and social integration showed reverse causality; that is, whether activity at one reporting period predicted social engagement in the next reporting period.

Results

Descriptive Information

Participants typically reported contact with one to two types of social ties (e.g., spouse, children, friends) in any 3-hr period (range of 0–19). We also looked at diversity of behaviors; participants typically engaged in 3–4 behaviors in a 3-hr period (range of 0–12 sets of behaviors; Table 1). Average physical activity counts were 10,707 per 3-hr period, though the standard deviation was large (10,276 activity counts). On average, participants spent about half their time being sedentary during each 3-hr period ranging from 0% to 100% of the time. To illustrate a typical participant, Figure 1 shows Day 3 for a participant with the sample average for social engagement. Notably, all forms of activity increased in sync throughout the day and then declined.

Social Engagement, Behaviors, and Physical Activity

To test whether engagement with a greater variety of social ties is associated with a greater variety of behaviors throughout the day, a multi-level model included diversity of social ties encountered in the prior 3 hr as the predictor, and diversity of behaviors as the outcome. As shown in Table 2, the diversity of social ties encountered in the prior 3 hr was associated with a greater variety of behaviors.

We estimated the same three-level model, with Actical data (activity counts, sedentary behaviors) as the outcome to test whether encounters with diverse social ties were associated with physical activity. Again, diversity of social encounters predicted greater physical activity and a smaller proportion of time sedentary in any 3-hr period (Table 2).

Encounters with close versus peripheral ties

We repeated the analyses to ascertain whether behaviors and activity reflected encounters with peripheral ties (i.e., people not in the social convoy) versus close ties (i.e., named in the convoy). Both close and peripheral ties were associated with greater diversity of behaviors and time sedentary, but only peripheral tie interactions were associated with greater physical activity (Table 3).

Positive and Negative Mood

We considered whether encounters with diverse social ties were associated with more positive mood and less negative mood, treating the mood indices at each 3-hr assessment as the outcomes. Encounters with diverse ties and diverse behaviors predicted more positive mood at each 3-hr interval (Table 4). Similarly, greater physical activity and less sedentary behavior (as measured by the Actical) predicted better positive mood. The models for negative mood were not significant (not shown).

Encounters with close versus peripheral ties

We examined whether encounters with close or peripheral ties accounted for associations with more positive mood; only encounters with close ties, not with peripheral ties, were significant (Table 5).

Post Hoc Tests

We estimated models to ascertain whether patterns were consistent for all 14 waking behaviors. Participants who encountered a greater variety of ties were more likely to engage in each activity, except for reading, television viewing, and computer/electronics usage. We also found that patterns were the same when we examined separate models for the most frequent behaviors grouped together (e.g., eating, television, chores, electronics/computer) and less frequent behaviors grouped together.

We also re-estimated the models breaking down the peripheral ties further into strangers versus acquaintances (i.e., close ties, acquaintances, strangers as predictors). On average, across all days of the study, participants encountered 2.63 strangers, constituting 7% of all assessments. Both encounters with strangers and acquaintances predicted greater diversity of behaviors.

Period of day (e.g., early morning, midday, evening) may explain associations between social engagement, behaviors, and physical activity. People tend to be more engaged in a variety of activities in the middle of the day compared with early morning or evening when they are more likely to be at home and involved in self-care (showering, getting ready for bed). Early morning periods tended to be defined by self-care behavior, so we reran models using only data from the evening. The pattern of findings held, even when selecting for 6 p.m. until bed time.

Table 2. Multilevel Regression Predicting Waking Activities, Physical Activity, and Time Sedentary From Encounters With Diverse Ties

Variable	Self reports		Actical measurements			
	Diversity		Activity count		Percentage of time sedentary	
	B	SE	B	SE	B	SE
Fixed effects						
Intercept	2.52***	0.73	29543.00***	5048.70	2.20	12.05
Encounters with diverse ties[a]	0.29***	0.02	985.03***	104.35	–4.77***	0.24
Covariates						
Age	–0.00	0.01	–346.69***	57.78	0.76***	0.14
Gender[b]	–0.45***	0.11	–822.95	797.09	3.49	1.90
Education[c]	0.15***	0.04	315.12	257.51	0.01	0.61
Physical health[d]	0.12*	0.05	1412.73***	382.70	–3.38***	0.91
Marital status[e]	0.23	0.12	825.22	811.95	–0.01	1.94
Minority status[f]	–0.05	0.13	–967.29	911.72	1.26	2.18
Random effects						
Intercept VAR (Level 2: day)	0.06**	0.03	0.00	—	0.00	—
Intercept VAR (Level 3: participant)	0.67***	0.07	30130665.00***	2997962.00	173.78***	17.06
Residual VAR	2.07***	0.04	67899802.00***	1386869.00	353.37***	7.22
–2 log likelihood	22403.8		106336.5		44751.8	

Note. *n* = 313 participants, *n* = 6,262 assessments. The outcome variable was the total number of types of waking activities that participants had every 3 hr throughout the day (14 in total, excluding sleeping), participants' averaged activity count and percentage of time being sedentary every 3 hr.
[a]Within-person centered variable: the number of encounters with different types of social ties every 3 hr throughout the day (centered on the average of these encounters per participant).
[b]1 = *male*, and 0 = *female*.
[c]1= *no formal education*, 2 = *elementary school*, 3 = *some high school*, 4 = *high school*, 5 = *some college*, 6 = *college*, 7= *some post college education*, 8 = *advanced degree*.
[d]1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *very good*, and 5 = *excellent*.
[e]1= *married*, and 0 = *not married*.
[f]Coded as 1= *minority*, and 0 = *nonminority*.
*p < .05. **p < .01. ***p < .001.

We tested whether diversity of behaviors, physical activity, and proportion of time sedentary served as mediators of the association between diversity of social ties and positive mood using SEM (Preacher & Hayes, 2008). Findings revealed that diversity of social ties and indices of behaviors and activity had independent effects on positive mood.

Further, we asked whether the association between activity and social integration showed reverse causality by examining lagged effects, analyzing whether activity at one reporting period predicted diverse social encounters in the next reporting period. Physical activity and time sedentary from the Actical were significantly associated with encounters with more diverse social ties at the next measurement occasion. Diverse behaviors did not predict subsequent engagement with social ties (Supplementary Table 2).

Discussion

Decades of research demonstrate strong effects of social relationships on well-being. Most studies have focused on the roles of close family and friends for health (Holt-Lunstad et al., 2010). Only a few studies have examined why having a diverse set of social ties is associated with better physical and emotional well-being, and they have relied on global ratings of social involvement and activity (Baker et al., 2005; Litwin, 2003). Using a within-person design, we found that involvement with a wider array of social ties was associated with greater activity throughout the day. We found that social engagement co-occurs with activity rather than physical activity *causing* social engagement (as illustrated in Figure 1). That is, behaviors and physical activities often occur in the context of sustained social engagement. As such, these findings provide compelling evidence for understanding the processes underlying social integration, and the interplay between engagement with social ties, behaviors, and activities.

We also broke new ground by comparing close social ties and peripheral social ties. Both types of social ties were uniquely related to greater diversity of activity. Yet, only close social ties were uniquely related to higher levels of positive mood, and only peripheral ties were uniquely associated with greater physical activity. These patterns support the idea that different social ties serve different functions (Fingerman, 2009; Fiori et al., 2007) and help to explain the benefits of having diverse social ties (both close and peripheral) to psychological and physical well-being.

Table 3. Multilevel Regression Predicting Diversity of Activities, Physical Activity and Time Sedentary From Encounters With Close and Peripheral Social Ties

	Self reports		Actical measurements			
	Diversity		Activity count		Time sedentary	
Variable	B	SE	B	SE	B	SE
Fixed effects						
Intercept	1.99**	0.72	28454.00***	5023.64	8.40	11.90
Encounters with close ties[a]	0.55***	0.06	−149.63	345.85	−2.49**	0.79
Encounters with peripheral ties[a]	0.62***	0.04	2712.20***	251.09	−11.27***	0.58
Covariates						
Age	0.00	0.01	−344.57***	57.52	0.75***	0.14
Gender[b]	−0.40***	0.11	−663.18	792.19	2.87	1.88
Education[c]	0.13***	0.04	261.93	255.97	0.19	0.61
Physical health[d]	0.13*	0.05	1405.32***	380.94	−3.34***	0.90
Marital status[e]	0.06	0.12	836.48	814.95	0.85	1.93
Minority status[f]	−0.15	0.12	−1250.12	905.47	2.47	2.14
Random effects						
Intercept VAR (Level 2: day)	0.05*	0.03	0.00	—	0.00	—
Intercept VAR (Level 3: participant)	0.65***	0.06	29891846.00***	2967297.00	169.11***	16.65
Residual VAR	2.06***	0.04	67367553.00***	1371405.00	354.63***	7.22
−2 log likelihood	22361.9		106970.8		45047.9	

Note. n = 313 participants, *n* = 6,262 assessments. The outcome variable was the total number of types of waking activities that participants endorsed every 3 hr throughout the day (14 in total), participants' averaged activity count and percentage of time being sedentary every 3 hr.

[a]Having any encounters with a close tie (or a peripheral tie) every 3 hr throughout the day.

[b]1 = *male*, and 0 = *female*.

[c]1 = *no formal education*, 2 = *elementary school*, 3 = *some high school*, 4 = *high school*, 5 = *some college*, 6 = *college*, 7= *some post college education*, 8 = *advanced degree*.

[d]1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *very good*, and 5 = *excellent*.

[e]1= *married*, and 0 = *not married*.

[f]Coded as 1= *minority*, and 0 = *nonminority*.

$*p < .05.$ $**p < .01.$ $***p < .001.$

Diversity of Social Encounters and Daily Behaviors

Researchers posit that larger social networks contribute to better health because they protect people from potentially health-damaging stressors and enhance well-being (e.g., Gleason & Iida, 2015; Pietromonaco & Collins, 2017; Umberson & Montez, 2010). Findings from the current study support theorists who argue that a more diverse social network co-occurs with engaging in a greater variety of behaviors throughout the day: being socially integrated, by definition, means being involved with diverse people engaging in diverse behaviors (Baker et al., 2005; Lee et al., 2018). We also found that social encounters are associated with more physical activity and fewer sedentary periods among older adults. Researchers have discussed how specific behaviors are related to better health outcomes; for example, researchers found that volunteering was related to better health in older adults (Fried et al., 2004). Findings from the current study suggest that co-occurring physical activity may be one mechanism explaining this association.

Furthermore, in this study, physical activity was associated with immediate subsequent social activity and positive mood throughout the day. The findings regarding lagged effects of physical activity support a distinct literature regarding global effects of physical activity on social engagement, happiness, and psychological well-being in late life. Several studies (including intervention studies) show these associations on a global level (Elavsky et al., 2005; McAuley et al., 2000; Netz, Wu, Becker, & Tenenbaum, 2005). As such, this also is the first study to show that physical activity is associated with immediate subsequent social activity and positive mood on a daily basis, supporting the premise that physical activity is a catalyst to positive emotion and social engagement.

Not surprisingly, social engagement did not co-occur with solitary behaviors (e.g., TV viewing, reading, and computer electronics usage). It is not clear whether these findings extend to younger people. For example, young adults use computers for social media or social online games (Granic, Lobel, & Engels, 2014). Indeed Fortnite became the most popular videogame of 2017 with over 200 million players who battle one another for hours (Fitzgerald, 2018). As such, some of the solitary behaviors in this study may be social behaviors in young adulthood.

Table 4. Multilevel Regression Predicting Positive Mood From Encounters With Diverse Ties and Diverse Activities

Variable	B	SE	B	SE
Fixed effects				
Intercept	3.52***	0.57	3.47***	0.57
Encounters with diverse ties[a]	0.04***	0.00	0.03***	0.00
Diverse activity[b]	—	—	0.02***	0.00
Covariates				
Age	−0.01	0.01	−0.01	0.01
Gender[c]	−0.09	0.09	−0.08	0.09
Education[d]	−0.02	0.03	−0.02	0.03
Physical health[e]	0.12**	0.04	0.12**	0.04
Marital status[f]	0.20*	0.09	0.20*	0.09
Minority status[g]	0.10	0.10	0.10	0.10
Random effects				
Intercept VAR (Level 2: day)	0.05***	0.00	0.05***	0.00
Intercept VAR (Level 3: participant)	0.46***	0.04	0.46***	0.04
Residual VAR	0.13***	0.00	0.13***	0.00
−2 log likelihood	7167.7		7164.4	

Note. n = 313 participants, *n* = 6,262 assessments. The outcome variable was participants' positive mood every 3 hr. Participants rated the extent to which they experienced three positive emotions (e.g., content, loved, calm) from 1 = *not at all*, to 5 = *a great deal*. We averaged participants' ratings across these emotions.
[a]Within-person centered variable: the number of encounters with different types of social ties every 3 hr throughout the day (centered on the average of these encounters per participant).
[b]The total number of types of waking activities that participants had every 3 hr throughout the day (14 in total).
[c]1 = *male*, and 0 = *female*.
[d]1= *no formal education*, 2 = *elementary school*, 3 = *some high school*, 4 = *high school*, 5 = *some college*, 6 = *college*, 7= *some post college education*, 8 = *advanced degree*.
[e]1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *very good*, and 5 = *excellent*.
[f]1= *married*, and 0 = *not married*.
[g]Coded as 1= *minority*, and 0 = *nonminority*.
$*p < .05.$ $**p < .01.$ $***p < .001.$

Close versus peripheral ties

Interacting with peripheral *or* close ties was associated with diverse behaviors, but only interactions with peripheral social ties were associated with greater physical activity. In late life, close social ties provide emotional and instrumental support (Rook & Charles, 2017). But network diversity seems to enhance well-being beyond the benefits of a network of close ties (e.g., Fiori et al., 2007; Litwin et al., 2006). Our findings suggest that interacting with peripheral social ties may benefit health because these interactions co-occur with physical activity.

Social Encounters, Behaviors, and Mood

Recent research emphasizes the importance of having rich and varied experiences for well-being (Quoidbach et al., 2017). This argument holds that people remain more vitally engaged, challenged, and flexible when they experience a complex social environment. Findings in this study support that premise as diverse social encounters and behaviors were associated with better mood. We found that interacting with a greater variety of social ties was related to more positive emotions, but not less negative emotions. This finding was consistent with those of a previous study, where a greater variety of behaviors, including socializing and exercising, was related to positive, but not negative emotions in a sample of younger adults (Watson, 1988).

The importance of close social ties for positive affect among older adults is consistent with socioemotional selectivity theory (Charles & Carstensen, 2010). According to this theory, older adults maintain higher levels of emotional well-being in late life because they maintain connections with close and meaningful social ties and discard more peripheral ties. Moreover, theorists have suggested that social convoy members may serve as attachment figures who mitigate negative emotions and provide feelings of connections (Antonucci et al., 2010). Findings may differ for young adults. Socioemotional selectivity theory suggests younger people place greater value on peripheral ties than do older adults (Charles & Carstensen, 2010), and we speculate that involvement with peripheral ties may generate even more positive mood in young adulthood.

Limitations and Future Directions

The study is constrained by several limitations. First, we contrasted close family and friends to more peripheral social ties via measurement of the social convoy. Yet, participants may value social ties not named in their top 10 social ties. Despite

Table 5. Multilevel Regression Predicting Positive Mood From Encounters With Close and Peripheral Ties and Diverse Activities

Variable	*B*	*SE*	*B*	*SE*
Fixed effects				
Intercept	3.47***	0.56	3.43***	0.56
Encounters with close ties[a]	0.09***	0.02	0.08***	0.02
Encounters with peripheral ties[a]	0.02	0.01	0.01	0.01
Diverse activity[b]	—	—	0.02***	0.00
Covariates				
Age	−0.01	0.01	−0.01	0.01
Gender[c]	−0.08	0.09	−0.08	0.09
Education[d]	−0.02	0.03	−0.02	0.03
Physical health[e]	0.12**	0.04	0.12**	0.04
Marital status[f]	0.18	0.09	0.17	0.09
Minority status[g]	0.09	0.10	0.10	0.10
Random effects				
Intercept VAR (Level 2: day)	0.05***	0.00	0.05***	0.00
Intercept VAR (Level 3: participant)	0.46***	0.04	0.46***	0.04
Residual VAR	0.13***	0.00	0.13***	0.00
−2 log likelihood	7205.7		7186.9	

Note. $n = 313$ participants, $n = 6,262$ assessments. The outcome variable was participants' positive mood every 3 hr. Participants rated the extent to which they experienced each of three positive emotions (e.g., content, loved, calm) from 1 = *not at all* to 5 = *a great deal*. We averaged participants' ratings across these three emotions.

[a]Having any encounters with a close tie (or a peripheral tie) every 3 hr throughout the day.

[b]The total number of types of waking activities that participants had every 3 hr throughout the day (14 in total).

[c]1 = *male*, and 0 = *female*.

[d]1 = *no formal education*, 2 = *elementary school*, 3 = *some high school*, 4 = *high school*, 5 = *some college*, 6 = *college*, 7 = *some post college education*, 8 = *advanced degree*.

[e]1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *very good*, and 5 = *excellent*.

[f]1 = *married*, and 0 = *not married*.

[g]Coded as 1 = *minority*, and 0 = *nonminority*.

*$p < .05$. **$p < .01$. ***$p < .001$.

this limitation, however, the current study offered a more extensive examination of diversity of social encounters (e.g., Cohen et al., 1997) by examining encounters in daily life. Second, the EMA assessments spanned a 3-hr period, and we did not examine causal direction between engagement in activity, emotional experience, and physical activity in the moment. Future studies may instead focus on more intensive, shorter periods to assess causality. Third, longitudinal data across a significant time period are needed to examine whether higher levels of physical activity and engagement in a diversity of behaviors predict health outcomes.

The current study provides a window into the social lives of older adults. We confirmed associations between engagement with close friends and family members in keeping active and experiencing positive emotions across the daily lives of older adults. In addition, we examined the unique benefits from interacting with peripheral ties for engagement in activities and behaviors. These findings suggest unique benefits of social engagement with peripheral ties, compared with close social ties, and add new evidence that peripheral ties may benefit the health of older people. Together, these findings offer new insights into the nuanced link of social integration and well-being via behaviors and activity.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

Conflict of Interest

None reported.

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