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Research Article

Features of Daily Social Interactions That Discriminate Between Older Adults With and Without Mild Cognitive Impairment

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Abstract

Objectives: Detecting subtle behavioral changes in everyday life as early signs of cognitive decline and impairment is important for effective early intervention against Alzheimer's disease. This study examined whether features of daily social interactions captured by ecological momentary assessments could serve as more sensitive behavioral markers to distinguish older adults with mild cognitive impairment (MCI) from those without MCI, as compared to conventional global measures of social relationships.

Method: Participants were 311 community-dwelling older adults (aged 70–90 years) who reported their social interactions and socializing activities 5 times daily for 14 consecutive days using smartphones.

Results: Compared to those with normal cognitive function, older adults classified as MCI reported less frequent total and positive social interactions and less frequent in-person socializing activities on a daily basis. Older adults with and without MCI, however, did not show differences in most features of social relationships assessed by conventional global measures.

Discussion: These results suggest that certain features of daily social interactions (quality and quantity) could serve as sensitive and ecologically valid behavioral markers to facilitate the detection of MCI.

Keyword: Behavioral markers, Cognitive decline, Ecological momentary assessments, Social activities, Socializing

As the population of the United States ages, Alzheimer's disease (AD) is rapidly growing to be one of the most expensive health conditions (Alzheimer's Association, 2019). Detecting early signs of the transition from normal cognitive aging to mild cognitive impairment (MCI)—a phase that often precedes the onset of AD (Dubois et al., 2016; Petersen, 2004)—is critical for effective early intervention and treatment against AD. Detecting early signs of MCI using clinic-based tests or biomarkers is expensive and/or invasive and unlikely to be practical in large-scale population screening (Kourtis et al., 2019). Recent research suggests that behavioral disruptions or impairment resulting from the underlying neurobiological changes can precede AD diagnosis by years and are commonly seen in individuals with MCI as early markers of impaired cognitive function (Creese et al., 2019; Jost & Grossberg, 1996; Kourtis

et al., 2019). The development of mobile and wearable technologies (e.g., smartphones, tablets, smartwatches) provide opportunities to better identify behavioral changes in daily life, including social interactions and socializing, as a more cost-effective and sensitive tool to detect the transition from normal cognitive aging to MCI (Dodge, Mattek et al., 2015; Kourtis et al., 2019). The goal of the current study was to use an ecological momentary assessment (EMA) approach and smartphones to better capture patterns of daily social interactions associated with cognitive decline, and identify specific features of daily social interactions that could serve as ecologically valid and sensitive behavioral markers to distinguish older adults classified as MCI from those without MCI. The EMA approach typically has individuals report on their current behaviors and experiences several times a day for a given number of days in their natural environments, thereby enabling an accurate characterization of individuals' daily social experiences in real-world contexts (Shiffman et al., 2008; Smyth et al., 2017).

Social interaction is a central feature of daily life and involves a variety of cognitive functions and resources. Having a successful social interaction is cognitively demanding, requiring an individual to maintain topics of conversation in one's memory; pay attention and adapt to others' perspectives; infer others' expectations, thoughts, and emotions; and inhibit irrelevant or inappropriate behavior during the interaction (Maki et al., 2020; Ybarra & Winkielman, 2012; Ybarra et al., 2008). Impaired cognitive function may make it difficult for older adults to identify social cues required for smooth interactions and conversations, leading to a withdrawal from socializing. Diminished cognitive function could also make it challenging to perform and enjoy social interactions due to individuals' declining confidence in their ability to carry on a successful interaction. It has been shown that compared to those with intact cognition, older adults with MCI demonstrated a speaking pattern during one-on-one conversations which reflects subtle difficulties with semantic fluency and the executive and self-monitoring aspects of conversations (Dodge, Mattek et al., 2015). In addition, among individuals with mild-to-moderate AD, those who are more aware of increasing word-finding failures reported less frequency and enjoyment of social leisure activities than those with less awareness (Farrell et al., 2014). Therefore, changes in everyday social interactions may be behavioral manifestations of early cognitive decline and could serve as sensitive markers to detect MCI.

Despite the growing interest in the identification of behavioral markers of cognitive decline, little research has examined how impaired cognition manifests in *day-to-day* social interactions. Past research has mostly relied on global, retrospective measures on social relationships. These global measures assess people's general impressions or global beliefs about their social relationships (e.g., "How much does your family really care about you?"), or their recollection of behaviors or experiences over lengthy time periods (e.g., "In the past 12 months, how often did you get together socially with friends or relatives?" Kelly et al., 2017; Kuiper et al., 2015). The accuracy of global measures may be hampered by recall biases, especially for individuals with impaired cognitive function (e.g., Boyle et al., 2010; James et al., 2011). Furthermore, global measures are often administrated infrequently (e.g., at a single time point), and cannot sensitively capture the moment-to-moment changes in individuals' everyday social interactions and socializing activities. Finally, global measures may provide useful information on individuals' overall social relationships and connectedness, which may not match their everyday social interactions or activities. There is a growing number of studies using EMAs to examine daily life experiences among older adults, including daily activities (Bielak et al., 2017), social and emotional experiences (Pauly et al., 2017), and physical health (Zhaoyang et al., 2019). A recent study also found evidence to support the general feasibility of using smartphone-based EMAs to study daily experiences in older adults with MCI (Bartels et al., 2020). To date, however, no prior studies have used EMAs to examine how impaired cognition would manifest in older adults' everyday social experiences, and which specific features of daily social interactions and socializing could sensitively distinguish older adults with and without MCI.

The Present Study

The current study aimed to characterize the daily social life of older adults and examine which features of daily social interactions and socializing activities could differentiate older adults with and without MCI. Specifically, we examined multiple indicators of important features of daily social interactions and socializing (i.e., quantity/frequency, quality, and diversity of partner types) that have been linked with cognitive function and health in later life (Ali et al., 2018; Zhaoyang et al., 2019). These features of social interactions and socializing were assessed using EMAs at near real time, in naturalistic environments of older adults, thereby providing a more holistic and accurate picture of their everyday social life. According to past research, impaired cognitive function may make it difficult for older adults to engage in and have satisfying social interactions (Dodge, Mattek et al., 2015; Farrell et al., 2014), especially with a variety of different partners (Ali et al., 2018). Therefore, we expect that older adults with MCI would have less frequent and less positive daily social interactions compared with those with intact cognition; those with MCI would also have less diversity in their social interaction partners (i.e., having social interactions with fewer types of interaction partners).

Older adults' social relationships were also assessed by conventional global measures in this study and we conducted exploratory analysis to examine whether older adults with and without MCI also demonstrated

differences in similar features of social relationships (quantity, quality, and diversity). This analysis seeks to explore whether daily social interactions assessed by EMAs were more sensitive to distinguish between MCI and normal cognition than social relationships assessed by global measures.

Method

Participants

Data were drawn from the EMA data collection as part of the ongoing Einstein Aging Study (EAS), collected between May 2017 and February 2020. Participants in EAS were recruited via systematic random sampling from Medicare and New York City Registered Voter Lists for Bronx County. Introductory letters were mailed to potential participants with valid addresses and phone numbers. Follow-up phone screens were conducted to determine eligibility (i.e., English-speaking community-residing individuals who are ambulatory and aged ≥70 years) and to enroll those who agreed to participate. Exclusion criteria included having significant hearing or vision loss; current substance abuse and severe psychiatric symptoms that may interfere with testing; alcohol or substance abuse; chronic medicinal use of opioids or glucocorticoids or treatment for cancer within the last 12 months; or being non-English speaking, institutionalized, or nonambulatory. Participants who were diagnosed with dementia using DSM-IV criteria (American Psychiatric Association, 1994) were not included in this study. The final sample included 311 older adults (see Table 1 for sample demographic information).

Procedure

Following the initial phone-screening assessment, eligible participants completed the consent process and were invited to attend a visit to the research clinic. During this visit, they completed questionnaires to assess demographic and psychosocial characteristics, the Uniform Data Set neuropsychological battery to assess cognitive function (Weintraub et al., 2018), and 1.5 hr of training on the study protocol and use of study smartphones. The day after the training, the participants began a 2-day practice session of EMA followed by a 14-day formal EMA session using the study smartphones that were programmed for this study (with scheduled surveys and disabled other phone functions). The EMA protocol (both practice and formal sessions) involved a self-initiated wake-up survey, a self-initiated end-of-day survey, and four quasi-randomly beeped surveys each day using study smartphones. The interval between beeped surveys was approximately 3.5 hr; beep times varied across days of the week but were programmed according to participants' self-reported wake-up schedules. After the EMA session, participants returned the study smartphones during the post-EMA clinic visit and the data were downloaded from the smartphones. Participants completing all aspects of data collection (i.e., clinic visit and EMA session) received $160 as compensation.

This study used data from baseline cognitive status, demographics and global measures on social relationships, and the EMAs (beeps and end-of-day) on daily social interactions collected via smartphones. The 311 participants provided 14,506 beep surveys and 3,498 end-of-day surveys over the 14-day period of the formal EMA session. On average, participants completed 13.65 days of EMAs (*SD* = 1.34; range = 3–14 days), 82.92% of all

Table 1. Sample Descriptive Information

	MCI group (*N* = 100)	Non-MCI group (*N* = 211)	Difference test (MCI vs non-MCI)
	Mean (*SD*)	Mean (*SD*)	t/χ^2 test
Sex (male)	33.00%	32.57%	0.00
Age (years)	77.79 (4.90)	76.58 (4.80)	–2.05*
Race/ethnicity			
White	34.00%	50.71%	7.64**
Black	48.00%	36.49%	3.74
Hispanic White	10.00%	9.95%	0.00
Hispanic Black	5.00%	1.90%	2.33
Asian	2.00%	0.95%	0.59
Other	1.00%	0	
Education (years)	14.20 (3.66)	15.35(3.46)	2.62**
Employment (yes)	5.00%	10.43%	2.52
Income	2.38 (0.71)	2.51 (0.65)	1.60
Married (yes)	29.00%	36.49%	1.70
Live alone (yes)	56.00%	52.13%	0.41

Notes: MCI = mild cognitive impairment. Means or percentages are presented outside of the parenthesis and *SD*s are inside of the parenthesis. Chi-squared test was used for categorical variables; *t* test was used for continuous variables. Income was coded as 1 = <$15,000; 2 = between $15,001 and $30,000; and 3 = >$30,000.
*$p < .05$. **$p < .01$.

assigned beep surveys, and 79.58% of all assigned end-of-day surveys. Participants without MCI had significantly higher compliance rates on beep surveys (*M*s = 85.03% vs 78.46%, $t = 2.92$, $p = .004$) and end-of-day surveys (*M*s = 83.89% vs 70.50%, $t = 3.78$, $p = .000$) than did participants with MCI. Missing data analyses revealed that the compliance rates of beep and end-of-day surveys were not significantly associated with any demographic variables except for education: more years of education were associated with higher compliance rates ($\gamma = 0.12$, $p = .037$ for beep surveys and $\gamma = 0.28$, $p < .000$ for end-of-day surveys).

Measures

Ecological momentary assessments on daily social interactions

Multiple indicators of social interactions and socializing features were measured by EMAs five times each day. Descriptive information on key study variables are presented in Table 2.

Daily social interactions.—The quantity, quality, and partner diversity of daily social interactions were assessed at beep and end-of-day surveys in the same way.

1. Quantity: At each survey, participants were asked whether they had any social interactions (defined as talking or spending time with someone in person, by phone/computer or by texting) since the last survey (i.e., in the past 3–4 hr). The answer "yes" to this question across five surveys within each day were summed up to indicate the frequency of assessed social interactions per day (range: 0–5).
2. Quality: If participants responded having any social interactions, they were then asked to select whether their most recent social interaction was "pleasant," "unpleasant," "neutral," or "both pleasant and unpleasant." The sum of reported "pleasant" and "unpleasant" social interactions from five surveys each day were used to indicate the frequency of captured positive and negative social interactions per day respectively (range: 0–5).
3. Diversity of partners: If participants responded having any social interactions, they were also asked to select the partner(s) involved in the most recent social interaction from a list including spouse/partner, children, other family members, friends, neighbors, acquaintances, strangers, and others. The count of all selected different types of partners across five surveys within each day were used as the index of diversity of social interaction partners each day (range: 1–8). In addition, a person-level diversity index across all reported social interactions over 14 days was calculated using Shannon's (1948) entropy index (Shannon, 1948; Zhaoyang et al., 2018).

In-person and online socializing.—At beep and end-of-day surveys, participants were asked what activities have they done since the last survey (i.e., in the past 3–4 hr). Participants

Table 2. Descriptive Information on Key Study Variables

	MCI group ($N = 100$)	Non-MCI group ($N = 211$)	1	2	3	4	5	6
	Mean (*SD*)	Mean (*SD*)	Correlations[b]					
Momentary assessments on daily social interactions[a]								
1. Any daily social interactions	3.00 (1.15)	3.37 (1.08)	—	.79***	.08	.28***	.53***	.21**
2. Positive daily social interactions	2.59 (1.18)	2.94 (1.07)	.81***	—	−.22**	.10	.40***	.25***
3. Negative daily social interactions	0.03 (0.09)	0.03 (0.10)	−.13	−.22*	—	.09	.09	−.06
4. Diversity of daily interactions partners	0.66 (0.17)	0.68 (0.15)	−.05	−.20	−.10	—	.29***	.14*
5. Daily in-person socializing	1.29 (1.12)	1.66 (1.08)	.61***	.52***	−.07	.08	—	.24***
6. Daily online socializing	0.48 (0.97)	0.58 (0.91)	.11	.05	.05	.10	.16	—
Global measures on social relationships								
1. Number of close social relationships	12.13 (7.40)	12.24 (6.88)	—	.30***	.19**	−.04	.23***	
2. Contact frequency with social partners	3.73 (0.70)	3.87 (0.64)	.41***	—	.15*	.19**	.07	
3. Social support	3.88 (0.92)	4.04 (0.85)	.16	.23*	—	.00	.38***	
4. Social strain	1.63 (0.54)	1.54 (0.47)	.16	.20*	−.08	—	.11	
5. Diversity of social relationships	3.00 (0.74)	3.08 (0.77)	.14	−.05	.24***	−.02	—	

Notes: MCI = mild cognitive impairment. Range for scales: [0–5] for any daily social interactions, positive daily social interactions, negative social interactions, daily in-person socializing, and daily online socializing; [0–1] for diversity of daily interactions partners; [1–6] for contact freq. with social partners; [1–5] for social support; [1–4] for social strain; [0–4] for diversity of social relationships.

[a]Momentary assessments were aggregated at the person level. [b]Correlations for MCI group were displayed below the diagonal (lower triangular matrix) and correlations for non-MCI group were displayed above the diagonal.

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

could select all activities that they had done from a list including in-person socializing, social media use (e.g., Facebook), chores, self-care, watching TV, physical activity, and other activities. The sum of in-person socializing and social media use (e.g., Facebook) reported in five surveys within each day was used to indicate the frequency of reported in-person and online socializing per day, respectively (range: 0–5).

Global measures on social relationships

Features of social relationships were assessed using conventional global measures at baseline before the EMA session.

Quantity of social relationships.—The number of close social relationships and the overall contact frequency with relationship partners were used as indicators of the quantity of social relationships.

1. *Number of close social relationships* was assessed by four questions (Schuster et al., 1990; Turner et al., 1983). One question asked how close the participant's relationship with the spouse or partner is, and was recoded to indicate whether the spouse relationship was close (coded as 1) or not (coded as 0). Three questions were asked about number of close relationships with children, family members, and friends, respectively (e.g., *how many of your children would you say you have a close relationship with*?). Numbers of close relationships with spouse, children, family members, and friends were summed as the indicator of the total number of close relationships.
2. *Contact frequency* with social partners was measured by nine questions assessing the extent to which participants are in contact with children, other family, and friends via different channels separately (i.e., in-person, speak on the phone, write or e-mail): *on average, how often do you meet up [speak on the phone/write to or e-mail] with your children [other family/friends]?* (1 = less than once a year or never to 6 = three or more times a week). A mean score of answers to these nine questions was created to indicate the overall contact frequency with social relationship partners.

Quality of social relationships.—The social support and social strain were assessed as the positive and negative indicators of the quality of social relationships.

1. *Social support* was assessed by 12 questions from Patient-Reported Outcomes Measurement Information System scales on emotional, instrumental, and informational support (Hahn et al., 2014). An example item is: *I have someone who will listen to me when I need to talk* (1 = never to 5 = always). A mean score of answers to 12 questions was created to indicate the overall levels of social support.
2. *Social strain* was assessed by 16 questions adopted from the National Social Life, Health, and Aging Project (Cornwell et al., 2009). Four similar questions were asked about spouse/partner, children, other family members, and friends, respectively. An example item is: *how often does your spouse [children/family member/friends] criticize you?* (1 = never to 4 = often). A mean score of answers to 16 questions was created to indicate the overall levels of social strain.

Diversity of social relationships.—Four questions were asked about whether participants have (a) a spouse or cohabitating partner, (b) any living children, (c) any other immediate family, or (d) any friends (1 = yes, 0 = no; Schuster et al., 1990; Turner et al., 1983). A sum score of the "yes" responses to four questions was used as an index of the diversity or composition of social relationships (range: 0–4).

MCI criteria

MCI status of each participant was determined algorithmically using Jak/Bondi criteria (Bondi et al., 2014; Jak et al., 2009). The neuropsychological tests included measures from five cognitive domains with 10 neuropsychological instruments. These included (a) *Memory*: free recall from the Free and Cued Selective Reminding Test (Buschke, 1984) and Benson Complex Figure (Delayed) (Possin et al., 2011); (b) *Executive function*: Trail Making Test Part B (Reitan, 1958) and Phonemic Verbal Fluency (Tombaugh et al., 1999); (c) *Attention*: Trail Making Test Part A (Reitan, 1958) and Digit Span (Wechsler, 1987); (d) *Language*: Multilingual Naming Test (Ivanova et al., 2013) and Category Fluency (Monsch et al., 1992); and (e) *Visual–spatial*: Benson Immediate Recall (Possin et al., 2011) and WAIS III Block Design (Wechsler, 1987). The following actuarial criteria of MCI were used: (a) had impaired scores (defined as >1 *SD* below the age-, sex- and education-adjusted normative mean) on both measures within at least one cognitive domain; or (b) had one impaired score (defined as >1 *SD* below the age-, sex-, and education-adjusted normative mean) in three (out of five) cognitive domains; or (c) having functional decline assessed by the Instrumental Activities of Daily Living Scale (Lawton & Brody, 1969). If a participant met these criteria, the participant was classified as MCI; otherwise, the participant was considered to have normal cognition.

Covariates.—The following demographic and social context variables were assessed by questionnaires at baseline and included as covariates in all analyses: age (in years), sex (male =1, female = 0), race/ethnicity (1 = White, 2 = Black, 3 = Hispanic White, 4 = Hispanic Black, 5 = Asian, 6 = other), education (years in school), employment (1= currently employed, 0 = not employed), living status (1 = living alone, 0 = not living alone), and marital status (1 = married, 0 = not married).

Data Analysis

Multilevel Poisson and logistic models were used to examine whether participants with and without MCI differed in features of daily social interactions. The data from EMAs were structured hierarchically, with momentary assessments aggregated at the day level (Level 1) which then nested within person (Level 2). Thus, daily social interactions could vary across days and across persons. All analyses for count outcomes (i.e., frequencies of any and positive daily social interactions, frequency of in-person and online socializing, and types of diverse partners) were conducted using SAS (version 9.4) PROC GLIMMIX with Poisson distribution and the logit link function. Due to the high percentage of value "0" (97.63%) on the frequency of daily negative social interactions and the nonconvergence issue of the Poisson models for this outcome, a binary variable was created to indicate whether *any* negative social interactions were reported each day (1 = yes, 0 = no) and multilevel logistic models were used for this outcome. We first examined whether daily social interactions varied with MCI status in a series of random-intercept models in which MCI status (1 = MCI, 0 = normal cognition) was included as the only person-level independent variable (Model 1, Table 3) and each indicator of social interactions as the dependent variable. Covariates were then added into each model to test the unique effect of MCI status on daily social interactions beyond the demographics and social context variables (Model 2, Table 3).

Following similar steps, general linear models were used to examine whether participants with and without MCI differed in features of social relationships assessed by global measures. A series of general linear models were conducted to examine the effects of MCI status on each of the indicators of social relationship features (quantity, quality, diversity), with and without covariates (Model 1 and 2, Table 4). Given that our sample is diverse in terms of sex and race/ethnicity, exploratory analyses were also conducted to test whether the associations between MCI status and any features of daily social interactions or social relationship varied across sex or race/ethnicity.

Results

Descriptive Information

Older adults in our sample reported having social interactions on 3.26 out of five momentary assessments collected each day on average (*SD* = 1.12), including interactions in person, by phone/computer, or by texting. They also reported having in-person and online socializing on 1.54 (*SD* = 1.11) and 0.55 (*SD* = 0.93) out of five momentary assessments per day, on average. Among all rated social interaction episodes (*N* = 13,883), 84.38% were rated as pleasant, 0.81% as unpleasant, 10.79% as neutral, and 4.02% as both pleasant and unpleasant. It is worth noting that at the day level, 97.63% of all reported

Table 3. Results From Multilevel Models on the Effects of MCI Status on Features of Daily Social Interactions

Outcomes	Predictor: MCI status								
	Model 1 (unadjusted)					Model 2 (adjusted)				
	b	OR	*SE*	*p*	95% CI	*b*	OR	*SE*	*p*	95% CI
Any daily social interactions	−0.12	0.89	0.05	.012	[−0.22, −0.03]	−0.08	0.92	0.05	.104	[−0.17, 0.02]
Positive daily social interactions	−0.15	0.86	0.05	.004	[−0.26, −0.05]	−0.13	0.88	0.05	.013	[−0.24, −0.03]
Negative daily social interactions[a]	−0.23	0.79	0.29	.427	[−0.81, 0.35]	−0.14	0.87	0.31	.661	[−0.74, 0.47]
Diversity of daily interaction partners	0.02	1.02	0.04	.527	[−0.05, 0.09]	0.04	1.04	0.03	.286	[−0.03, 0.11]
Daily in-person socializing	−0.37	0.69	0.12	.001	[−0.59, −0.14]	−0.26	0.77	0.11	.020	[−0.48, −0.04]
Daily online socializing	−0.58	0.56	0.33	.076	[−1.22, 0.06]	−0.44	0.64	0.33	.175	[−1.09, 0.20]

Notes: 95% CI = 95% confidence interval for estimates; MCI = mild cognitive impairment; OR = odds ratio. *N* = 311 persons, 4,245 observations used in multilevel modeling models. MCI status: 1 = MCI, 0 = non-MCI. Model 1 is the model without any covariates; Model 2 included sex, age, race/ethnicity, education (years), employment, marital status, and living status as covariates. Poisson estimate was used for count outcomes.
[a]Logistic estimate was used for the binary outcome (predicting the probability of 1 = any negative social interactions that day vs no negative social interactions).

days (N = 4,038) did not have any unpleasant social interactions. In fact, the majority of the older adults in our sample (80.58%) did not report any unpleasant or negative social interactions across 14-day study period.

In terms of social interaction partners, more than half of social interaction occasions (55.47%) involved more than one type of partner. On average, participants interacted with two different types of partners every day. Most of these social interaction occasions involved family members or friends (88.37%). At the person level, participants reported 0.67 (SD = 0.15) mean scores for the entropy index of partner diversity, with "0" indicating all interactions were with a single type of partner and "1" indicating interactions spread evenly across all types of partners.

Regarding the features of social relationships assessed by global measures at baseline, older adults reported having three types of social relationships on average (out of four available types: spouse, children, family, and friends). They also reported having close relationships with 12.20 (SD = 7.04, range: 1–45) partners including spouse, children, other family, or friends. On average, they contacted their social relationship partners about once or twice a month, and reported high levels of social support (M = 3.99 on a 5-point scale) and low levels of social strain (M = 1.56 on a 4-point scale) of their social relationships. Descriptive statistics broken down by MCI classification were presented in Table 2.

Do Older Adults With and Without MCI Differ in Features of Daily Social Interactions and Socializing Activities?

In our sample of 311 older adults, 32% (N = 100) were classified as MCI and 68% were classified as non-MCI (N = 211). The MCI group included older participants, had lower percentage of Whites, and reported fewer years of education than the non-MCI group (Table 1).

Multilevel Poisson or logistic models were used to examine whether older adults with and without MCI differed in features of daily social interactions and socializing activities. As shown in Model 1 (Table 3), older adults with and without MCI demonstrated significant differences in several indicators of the quality and quantity of their daily social experience, including frequencies of having any social interactions, positive social interactions, and in-person socializing. Specifically, older adults with MCI reported 11% lower odds of having any social interactions and 14% lower odds of having positive or pleasant social interactions each day than those without MCI. In addition, older adults with MCI had 31% lower odds of having in-person socializing each day than those without MCI (Model 1, Table 3). Older adults classified as MCI also demonstrated a trend to have less frequent (44% lower odds) online socializing activities everyday than those without MCI, even though this group difference did not reach statistical significance (p = .076). After adjusting for covariates (sex, age, race/ethnicity, education, employment, marital status, and living status), the effects of MCI status on frequencies of positive social interactions and in-person socializing remained significant (Model 2, Table 3).

MCI status was not significantly associated with the frequency of negative daily social interactions or the diversity of interaction partners. We conducted further analyses to explore whether older adults with and without MCI differ in the frequency of interacting with specific types of partners. The results revealed that people with MCI had 30% lower odds of interacting with acquaintances (b = –0.36, OR = 0.70, p = .012) and a tendency to interact less (25% lower odds) with strangers (b = –0.29, OR = 0.75, p = .078) everyday than did those without MCI; but these two groups did not differ in the frequencies of interacting with other types of partners (e.g., spouse/partner, children, other family members, friends, neighbors). The exploratory analyses also revealed that none of the effects of MCI status on any features of daily social interactions or socializing was moderated by sex or race/ethnicity.

Do Older Adults With and Without MCI Differ in Features of Social Relationships Assessed by Global Measures?

The results from general linear models indicated that older adults with and without MCI showed a significant difference in one out of five features of social relationships assessed by conventional global measures (Model 2, Table 4). Specifically, older adults with MCI reported higher levels of strain and conflicts with family and friends than did those without MCI (b = 0.12, p = .042); and these two groups did not differ in the number of close relationships, contact frequency with relationship partners, social support, or diversity of social relationships. Again, the exploratory analyses indicated that neither sex or race/ethnicity moderated the association between MCI status and any features of social relationships.

Discussion

The current study examined whether daily social interactions could serve as sensitive behavioral markers to distinguish older adults with MCI from those with intact cognitive function. We compared several important features of daily social interactions and socializing (quantity, quality, diversity of partners) between older adults with and without MCI using data from a diverse community-dwelling cohort of older adults. The results demonstrated that compared with older adults without MCI, those classified as MCI reported less frequent total social interactions, positive social interactions, and in-person socializing on a

Table 4. Results From Regression Models on the Effects of MCI Status on Features of Social Relationships

	Predictor = MCI status							
	Model 1 (unadjusted)				Model 2 (adjusted)			
Outcomes	*b*	*SE*	*p*	95% CI	*b*	*SE*	*p*	95% CI
Number of close social relationships	−0.11	0.86	.901	[−1.79, 1.58]	−0.45	0.88	.606	[−2.18, 1.28]
Contact frequency with social partners	−0.14	0.08	.075	[−0.30, 0.01]	−0.09	0.08	.266	[−0.25, 0.07]
Social support	−0.15	0.11	.155	[−0.36, 0.06]	−0.13	0.11	.203	[−0.34, 0.07]
Social strain	0.09	0.06	.131	[−0.03, 0.21]	0.12	0.06	.042	[0.01, 0.24]
Diversity of social relationships	−0.08	0.09	.400	[−0.25, 0.10]	−0.03	0.06	.657	[−0.15, 0.09]

Note: 95% CI = 95% confidence interval for estimates; MCI = mild cognitive impairment. N = 311 persons. MCI status: 1 = MCI, 0 = non-MCI. Model 1 is the model without any covariates; Model 2 included sex, age, race/ethnicity, education (years), employment, marital status, and living status as covariates.

daily basis, suggesting that older adults with MCI experienced lower quality and quantity in their daily social interactions. In comparison, older adults with and without MCI did not differ in the majority of features of social relationships assessed by global measures. Together, these results provide some evidence that certain features of daily social interactions captured by EMAs in naturalistic settings have more discriminative power to detect older adults with MCI than social relationships measured by conventional global measures.

The complex and dynamic nature of social interactions require a person's capability to simultaneously engage and integrate different cognitive functions and skills including attention, working memory, inhibition, reasoning, and language (Dodge, Mattek, et al., 2015; Ybarra & Winkielman, 2012; Ybarra et al., 2008). Older adults with impaired cognitive function may experience greater difficulties in everyday social interactions as a result of cognitive decline, especially the deterioration of social cognition that is critical for communication and interaction (Maki et al. 2020). To our knowledge, this study is the first study that used EMAs to characterize different features of daily social interactions and socializing for older adults with and without MCI in their naturalistic environment. Our findings provide evidence that certain features of daily social interactions (quantity and quality) could sensitively differentiate older adults with and without MCI: those with MCI experienced less frequent in-person socializing and less frequent total and positive social interactions each day than those without MCI.

The majority of the features of social relationships measured by global measures did not differentiate older adults with MCI from those with normal cognitive function (with the exception of social strain). There are several possible explanations. First, the recall bias may limit the accuracy of global measures, especially for people with MCI due to their memory deficits. Also, retrospective recall in global measures may over-rely on older adults' schemas or past experience built over lifetime (Umanath & Marsh, 2014), and thus lag in detecting subtle changes in everyday behaviors associated with cognitive decline. Finally, it is also possible that the influences of cognitive deficits on social relationships may take longer to manifest, because the social relationships, especially the structural aspects (e.g., quantity, diversity/composition), are generally more stable and enduring compared with day-to-day social interactions.

It is interesting to note that older adults with and without MCI did not show significant differences in the frequency of daily negative social interactions. Given that all older adults reported very few occasions of negative social interactions (more than 80% participants reported no negative social interactions in this study), it is possible that there is not sufficient variation in the negative social interactions over a 2-week time period. Past research suggests that the influences of negative social interactions may

unfold over a longer timescale compared with the positive social interactions (Zhaoyang et al., 2019). Our finding that people with MCI reported more social strain in general than those without MCI may reflect the cumulative effects of negative social interactions over a longer period of time. Future research with longitudinal design is needed to test this speculation.

Additionally, the overall diversity index of interactions also did not distinguish people with and without MCI. The results from our exploratory analyses, however, indicated that older adults with MCI had less frequent daily interactions with acquaintances or strangers than did those without MCI. Therefore, it is possible that interacting with acquaintances or strangers is more cognitively demanding than interacting with more familiar or closer partners (e.g., spouse, children, other family members, friends). In other words, the specific type of partners, rather than the overall diversity of partners, has more discriminative power in identifying people with MCI.

There are several limitations that present promising avenues for future research. First, the data in this study were cross-sectional in nature and permitted only comparison between MCI versus non-MCI groups. Longitudinal data are needed to examine the diagnostic stability of MCI classification over time (Han et al., 2012), and whether impaired cognition would influence and/or be influenced by changes in social interactions over time. Second, this study did not directly examine which cognitive function (e.g., attention, working memory, inhibition) or psychological mechanisms may account for the observed group differences (MCI vs non-MCI) in features of daily social interactions. Future study would benefit from identifying cognitive or psychosocial factors that may help explain the changes in daily social interactions associated with cognitive impairment. Third, although smartphone-based EMAs at real time and in participants' natural environments greatly improve the accuracy and ecological validity of the assessments, they still rely on self-report and thus could be influenced by recall and social desirability bias. Future research may benefit from using technology-aided approaches and passively collected data (e.g., electronically activated recorder, in-home monitoring, social media data) to objectively assess social interactions beyond survey methods (Dodge et al., 2014).

In conclusion, our study joins the increasing interest in identifying behavioral markers of cognitive decline at the MCI stage and provides evidence that certain features of daily social interactions (e.g., quality and quantity) could serve as sensitive and ecologically valid behavioral markers to detect MCI among older adults. These findings could facilitate the development of more powerful and cost-effective screening tools for MCI, as well as early diagnosis and interventions for AD. In addition, the feasibility of using smartphone-based EMAs to characterize the daily social life in older adults with MCI also provide support for the development and evaluation of technology-aided interventions aimed to improve social skills or to enhance the socially engaged life among older adults with cognitive impairment (Dodge, Zhu, et al., 2015).

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Conflict of Interest

None declared.

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Data Availability

The data, analytic methods, and study materials on which the manuscript is based will be made available per request.

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