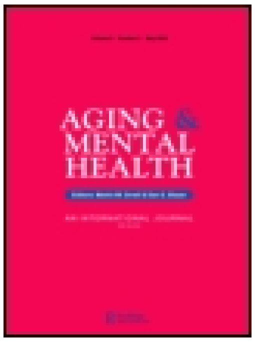

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The impact of social interactions and pain on daily positive and negative affect in adults with osteoarthritis of the knee

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ABSTRACT

This study utilized experience sampling methodology (ESM) to examine the relationship of social interactions with daily pain and mood symptoms in people with osteoarthritis (OA) of the knee. Two hundred sixty-eight adults with physician-diagnosed OA of the knee underwent a baseline in-person interview and subsequent week-long ESM protocol to assess their daily activity patterns, pain, and mood via phone interview four times a day. A coding system was developed to assess presence and type of social interactions based on subject self-report of activity patterns. Multilevel modeling was used to examine between- and within-subject variation in outcomes based on both global and momentary measures of social activities, pain, and mood, while controlling for key demographic and potentially confounding variables. Positive associations were demonstrated between the ratio of positive to negative affect and both global ($\beta = 0.49$, $p < .001$) and momentary, especially positive ($\beta = 0.24$, $p < .05$), social activity patterns. Additionally, the association between negative affect and pain ($\beta = -0.07$, $p < .01$) was attenuated in those with more baseline social interactions. Social interaction has the potential to influence mood in adults with OA of the knee, both on a global scale, and through daily variations in interactions. These interactions seem to be directly related to mood, as well as the apparently attenuating the relationship between pain and depression. Daily social interactions showed a robust positive association with contemporaneous positive affect.

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Arthritis is one of the most prevalent chronic health conditions in the United States, with osteoarthritis (OA) being the most common form (Ling & Bathon, 1998). It is expected that arthritis will affect 25% of the adult population by 2030, with obesity and advancing population age being leading factors in this projected rise in prevalence (Bitton, 2009; Hootman & Helmick, 2006; Sowers & Karvonen-Gutierrez, 2010).

Chronic illness, particularly chronic pain syndromes such as OA, has long been shown to increase the risk of negative health outcomes, including depression (Revenson, Schiaffino, Majerovitz, & Gibofsky, 1991; Penninx et al., 1997). Depression, in turn, is associated with increased pain severity, regardless of radiographic evidence of disease progression (Arnow et al., 2006; Creamer & Hochberg, 1997). It is essential that the interplay among social, psychological, and physical variables be explored to develop better strategies to improve the well-being of OA sufferers.

Positive social support is generally associated with improved physical, as well as psychological, well-being, especially in older adults (Berkman, Glass, Brissette, & Seeman, 2000; Bisconti & Bergeman, 1999; Russell & Cutrona, 1991; Seeman, 2000), and those with OA in particular (Ethgen et al., 2004). Similarly, emotional distress (e.g. anxiety and depression) is associated with poor social connectedness (Berkman et al., 2000). Social support is considered positive and beneficial to the extent that it promotes a sense of agency and belonging (Berkman, 1995). Part of why social relationships may have an impact on psychological and physical well-being is that having a strong social network may promote the seeking of and adherence to medical treatment via social pressures, as well as lead to the avoidance of negative experiences (e.g. financial or legal trouble) that would adversely influence psychological health (Cohen & Wills, 1985; Vina et al., 2013). Social support, depending on the type and the degree to which it addresses the needs created by a stressor, has been shown to have both direct and buffering effects on psychological well-being (Bisschop, Kriegsman, Beekman, & Deeg, 2004; Cohen & Willis, 1985; Penninx et al., 1997).

Additionally, specific experiences tied to social relationships, such as positive and negative social interactions, can have an impact on affective outcomes. Negative social interactions and reduced engagement with social activities have been found to increase the risk of depressive symptoms (Abbey, Abramis, & Caplan, 1985; Lakey, Tardiff, & Drew, 1994; Revenson et al., 1991; Rosemann et al., 2007). Some studies have indicated that positive social interactions can mitigate this effect, and that positive support could potentially have a greater influence on depressive symptoms than its negative counterpart (Finch, Okun, Pool, & Ruehlman, 1999; Okun & Keith, 1998; Revenson et al., 1991; Schuster, Kessler, & Aseltine, 1990; Sherman, 2003).

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This effect may vary depending on the nature of the relationship in question, however, and literature shows support for both having an effect on depression (Rook, 1997). Both pain and reduced social functioning are directly associated with increased depressive symptoms amongst those with OA of the knee (Bookwala, Harralson, & Parmelee, 2003). Further, social functioning alone has been revealed to have both direct and buffering effects on mood (Ferreira & Sherman, 2007; Kahana, Kahana, Namazi, Kercher, & Stange, 1997; Williamson & Schulz, 1992).

Furthermore, social support has been shown to buffer the relationship between having arthritis and depressive symptoms, especially in a severe disease state (Blixen & Kippes, 1999; Penninx et al., 1997). There is some evidence that simply the number of positive or negative social interactions can influence the degree of depressive symptoms, regardless of the type of relationship. For example, Zautra, Burleson, Matt, Roth, and Burrows (1994), in a study of women with rheumatoid arthritis (RA) and OA, found that a greater number of positive social interactions was associated with a lower degree of depressive symptoms in both subpopulations (Zautra et al., 1994; Penninx et al., 1997). Simply living with other people has been associated with greater psychological well-being (De Forge, Sobal, & Krick, 1989).

Most literature exploring the connections among pain, mood, and social support in OA sufferers has been retrospective in nature, which comes with inherent limitations. Retrospective studies of the interplay among these variables may be limited by the ability of participants to accurately recall momentary pain and mood states as they relate to particular events or actions. This concern is especially relevant in the context of chronic pain, as higher degrees of current pain or chronic depressed mood may lead to an overestimation of past pain or depression symptoms, though this finding is not universal (Affleck, Urrows, Tennen, & Higgins, 1992; Eich, Reeves, Jaeger, & Graff-Radford, 1985; Erskine, Morley, & Pearce, 1990; Jenkins, Hurst, & Rose, 1979; Linton, 1991).

In response to these concerns, some studies have utilized measures of pain that are more 'ecological' in the sense that participants rate their pain in something closer to real time, as they go about their lives (May, Junghaenel, Masakatsu, Stone, & Schneider, 2018; Smith, Brown, & Ubel, 2008). Such methods include daily diaries as well as brief surveys conducted electronically or by phone several times a day for several days or more. These methods are less reliant on participants' ability to accurately recall and aggregate their experiences, and have produced novel findings in chronic pain populations that sometimes diverge from those observed using traditional recall-based survey measures (May et al., 2018).

The use of more ecological/experience based methods also allows for exploration of the dynamic relationships between pain (and other symptoms) and emotional mood quality, coping strategies, and other concurrently experienced phenomena. Previous research based on daily measures has shown that pain has the potential not only to lead to worse mood, but also to moderate the linkage between particular coping strategies, such as seeking emotional support, and the degree of positive mood elicited. More pain has been associated with less positive mood despite the use of these adaptive strategies (Affleck et al., 1992, 1999; Keefe et al., 2004).

However, little has been done in the study of OA to account for the dynamic quality of pain perception and negative mood, including depressive symptoms, as they relate temporally to social interactions. Given that social interactions can play a role in pain coping, which has already been established to be a factor in the dynamic interaction between pain and mood, it is important to better explore this variable. While some within-day analyses have been conducted in the study of OA, as mentioned, the interplay between these common and uniquely influential factors as they relate to social interactions in particular has not been explored. Studies incorporating ecological analyses have the potential to lead to stronger and more reliable causal inferences, especially considering the reduction to confounding when comparing subjects to themselves (West & Hepworth, 1991).

This study aims to use the day-to-day experiences of its participants to better understand the relationship of social interactions with the daily perception of pain and fluctuations in depressed mood. Using the experience sampling method (ESM), we assessed changes in pain and mood throughout the day, for a total of four daily measures, over the course of one week. It was predicted that mood would be improved by social activities and positive social interactions. Additionally, it was expected that social activities and positive social interaction would attenuate the known direct association between pain and negative mood.

Methods

Sample description and recruitment

Participants consisted of 268 adults aged 50 and older with OA of the knee diagnosed by a physician. Exclusion criteria consisted of significant cognitive impairment, identified as greater than four errors on the Short Portable Mental Status Questionnaire (Pfeiffer, 1975); the presence of a life-threatening illness; comorbid disabling illness, such as RA or fibromyalgia, which might introduce confounding, and inability to complete interviews in English. These participants represent a subsample of a larger study examining racial disparities in OA outcomes; thus, all respondents identified as either African American or non-Hispanic white.

Recruitment was conducted from multiple sites in both western Alabama ($n = 161$, 60.1% of sample) and Long Island, New York ($n = 107$, 39.9% of sample). Alabama-based participants were recruited from The University of Alabama Medical Center outpatient clinic and a large private rheumatology clinic, as well as through flyers and public service announcements (PSAs) distributed at senior centers, local publications, and by word of mouth or other sources. The majority of New York participants were recruited from a large medical clinic affiliated with Stony Brook University Medical Center, with additional participants recruited via flyers, campus announcements (mass e-mail), and commercially provided lists of potentially eligible participants.

Clinic patients with a preexisting diagnosis of OA were recruited through a letter from the clinic director that provided information about the study and giving them the option to opt-out from participating. The project office was contacted directly in the case of respondents to flyers or PSAs. Screening for eligibility was conducted by telephone

Table 1. Sample characteristics ($n = 268$)*.

Age, range 48–98	63.92 ± 9.06
Sex	
Male, no. (%)	62 (23.1)
Female, no. (%)	206 (76.9)
Race	
Non-Hispanic white, no. (%)	156 (58.2)
African American, no. (%)	112 (41.8)
Employment status	
Employed, no. (%)	101 (37.7)
Unemployed, no. (%)	167 (62.3)
Income	
Low income (<$10,000–20,000), no (%)	87 (32.5)
Middle income ($20,001–50,000), no (%)	78 (29.1)
High income ($50,001–>70,001), no (%)	103 (38.4)
Baseline social activity patterns, range 1.1–4.4	2.49 ± 0.56
Global pain (PGC pain score), range 0–4	2.07 ± 0.87
Global depressed mood (CES-D score), range 0–54	11.51 ± 10.67
Momentary pain, range 1–5	2.06 ± 0.81
Momentary negative affect, range 1–4	1.40 ± 0.51
Momentary positive affect, range 1–5	3.27 ± 0.70
Interactions during ESM assessment	
No interaction, no. (%)	5648 (87.0)
Negative interaction, no. (%)	8 (1.00)
Neutral or professional interaction, no. (%)	775 (92.0)
Positive interaction, including help given, no. (%)	59 (7.0)

*Values are the mean ± SD unless stated otherwise. *PGC*, Philadelphia Geriatric Center; *CES-D*, Center for Epidemiologic Studies Depression Scale.

and respondents were mailed a package containing materials related to self-report measures and consent. An in-person interview was conducted after obtaining informed consent. Patients were selected and contacted based on established OA diagnosis, or the diagnosis was confirmed by a physician following receipt of signed consent by potential participants. Study methods and procedures were approved by University of Alabama and Stony Brook University Institutional Review Boards.

Baseline measures

At the initial in-person interview, demographic data were obtained, including age, sex, race, marital status, education, employment status, and income. To assess for social activities, a modified version of the Multilevel Assessment Instrument (MAI; Bookwala et al., 2003; Lawton, Moss, Fulcomer, & Kleban, 1982) assessing activity patterns over the preceding month was utilized, with a focus on social measures within the questionnaire for the purposes of this study. Scores for all activities involving likely social interactions (e.g. going to a senior center/attending a senior citizen's group, church/group/club meetings, eating out with friends/relatives, babysitting, visiting a distant relative/friend), totaling 16 of 22 total items, were averaged for analysis. In addition, global pain was ascertained using the Philadelphia Geriatric Center (PGC) Pain Scale, a 6-item intensity scale (Parmelee, 1994). The Center for Epidemiologic Studies Depression Scale (CESD), a 20-item measure with a score ranging from 0 to 60, was used to assess depressive symptoms (Radloff, 1977) (Table 1).

Experience sampling measures and procedure

ESM protocol consisted of four assessments a day by telephone over the course of a 1-week period beginning the day following the in-person interview, totaling 28 data points. The calls were conducted by trained research assistants over a 12-h period dictated by participant preference. Calls were randomized within 3-h blocks and occurred at least a half hour apart; three attempts for each assessment in 10-min intervals were made before data was categorized as missing. Participants were given freedom to silence their phones at their discretion with the option to call back. Response rate to phone calls was 78%.

Experience sampling included current activities, including location and others present at time of call, as well as current pain (based on a 1–5 intensity scale). Additionally, positive affect (e.g. energetic, happy, content) and negative affect (e.g. depressed, sad) were assessed using the 10-item PGC Positive and Negative Affect Scales (Lawton, Parmelee, Katz, & Nesselroade, 1996). For an overall composite of mood quality, we computed the ratio of positive to negative affect (Meeks, Van Haitsma, Kostiwa, & Murrel, 2012; Smith & Parmelee, 2016).

To evaluate momentary social interactions as they related to contemporaneous measures of pain and depressed mood, we utilized the standard, open ended question commonly used in ESM protocols asking the participants to indicate what they were doing just prior to receiving the phone call. Interviewers recorded the responses as they were stated (Horton, Strauman, Barrantes-Vidal, & Kwapi, 2011; Larson & Csikzentmihalyi, 1983). Later, a coding scheme was developed to categorize social interactions occurring at the time of each ESM assessment. A binary categorization was used to identify if there was 'no interaction' occurring or 'interaction' based on the activities in which the participant was engaged at the time of the call (e.g. talking to someone). If an interaction was occurring, it was further organized on a six category variable system based on the type of interaction from 'positive' to 'negative', with remaining categories consisting of 'help given', 'help received', 'neutral', and 'professional'. These values were grouped according to type of interaction into 'none/negative', 'neutral/professional', or 'positive'. Retrospective interactions mentioned as happening since last ESM assessment, rather than at time of call, were categorized using the same method. To assess interrater reliability, a randomly-generated 50-item data sample was used. After an initial briefing regarding coding protocol, independent raters reached 95% agreement, reflecting good consistency across raters (Table 1).

Statistical analysis

Because there are up to 28 data points per subject, we employed 2-level hierarchical linear modeling, which separately models between-subject (Level 2) and within-subject (Level 1) variation in outcomes. In addition, because negative affect is right skewed, with modal responses near the bottom of the scale, we employed a generalized linear approach (Poisson) for this variable. Positive affect and the computed ratio variable are both approximately normally distributed. Analyses were performed using SAS PROC GLIMMIX.

We first examined bivariate associations between our measures of social activities and ESM-assessed mood. Specifically, we used the global measure of social activities over the past month taken from the baseline interview (Level 2 predictor), as well as the ESM measure of social interaction (Level 1 predictor) to predict momentary affect ratio. Next, we added pain at both Level 2 (subject level

Table 2. Affect ratio as a function of momentary and global social interaction patterns ($n = 268$).

Covariance parameter estimates	b	SE	DF	Z or t[a]	p
Model 1: prediction of affect ratio					
Random effects					
Intercept	0.62	0.056		11.12	<0.01
Residual	0.465	0.009			
Fixed effects (Level 2)					
Social activities pattern	0.490	0.088	266	5.57	<0.01
Fixed effects (Level 1)					
No interactions (reference)					
Neutral/professional interactions	0.122	0.028	5671	4.28	<0.01
Positive interactions	0.242	0.096	5671	2.53	<0.05
Model 2: prediction of affect ratio with covariates					
Random effects					
Intercept	0.375	0.035		10.72	<0.01
Residual	0.453	0.009			
Fixed effects (Level 2)					
Age	0.001	0.01	257	0.11	0.91
Sex	−0.137	0.09	257	−1.44	0.15
Education level	0.008	0.03	257	0.29	0.77
Employment status[b]	−0.090	0.10	257	−0.87	0.39
Income	0.036	0.02	257	1.70	0.09
Race[c]	0.022	0.08	257	0.28	0.78
Site[d]	−0.137	0.09	257	−1.56	0.12
CESD depression at interview	−0.040	0.00	257	−8.49	<0.01
Social activities pattern at interview	0.197	0.08	257	2.61	<0.01
Mean ESM pain	−0.144	0.06	257	−2.53	<0.05
Fixed effects (Level 1)					
No interactions (reference)					
Neutral/professional interactions	0.123	0.03	5663	4.37	<0.01
Positive interactions	0.237	0.09	5663	2.52	<0.05
Centered ESM pain score	−.138	0.01	5663	−12.20	<0.01

[a]Random effect test statistics are based on the Z distribution; fixed effect test statistics are T's.
[b]0 = Employed, 1 = Non-employed.
[c]0 = Non-Hispanic whites, 1 = African Americans.
[d]1 = Alabama, 2 = Stony Brook.

Table 3. Positive and negative mood as a function of social interaction and pain ($n = 268$).

Covariance parameter estimates	b	SE	DF	Z or t[a]	p
Model 3: Prediction of positive affect with covariates					
Random effects: prediction of positive affect by interval					
Intercept	0.301	0.03		10.89	<0.01
Residual	0.258	0.01			
Fixed effects (Level 2):					
Age	0.005	0.01	257	1.13	0.26
Sex	−0.048	0.08	257	−0.57	0.57
Education level	0.035	0.02	257	1.43	0.15
Employment status[b]	0.034	0.09	257	0.37	0.71
Income	0.021	0.02	257	1.11	0.27
Race[c]	−0.091	0.07	257	−1.33	0.18
Site[d]	−0.159	0.08	257	−2.03	<0.05
CESD depression at interview	−0.031	0.00	257	−7.49	<0.01
Social activities patterns at interview	0.212	0.07	257	3.16	<0.01
Mean ESM pain	0.075	0.05	257	1.48	0.14
Fixed effects (Level 1):					
No interactions (reference)					
Neutral/professional interactions	0.138	0.02	5663	6.49	<0.01
Positive interactions	0.230	0.071	5663	3.23	<0.01
Centered ESM pain score	−0.052	0.01	5663	−6.09	<0.01
Model 4: GLIMMIX Poisson model of negative affect with covariates					
Fixed effects (Level 2)					
Age	0.0001	0.002	256	0.09	0.93
Sex	0.0367	0.029	256	1.28	0.20
Education level	0.0118	0.008	256	1.45	0.15
Employment status[b]	0.0305	0.031	256	0.99	0.32
Income	−0.0079	0.006	256	−1.30	0.20
Race[c]	−0.0480	0.024	256	−2.04	<0.05
Site[d]	0.0096	0.026	256	0.37	0.71
CESD depression at interview	0.0110	0.001	256	8.20	<0.01
Social activities pattern at interview	0.1144	0.059	256	1.93	0.06
Mean ESM pain	0.2871	0.066	256	4.51	<0.01
Social activities X ESM pain	−0.7253	0.026	256	−2.75	<0.01
Fixed effects (Level 1)					
No interactions (reference)					
Neutral/professional interactions	−0.0061	0.034	5663	−0.18	0.86
Positive interactions	−0.0518	0.116	5663	−0.45	0.66
Centered ESM pain score	0.0680	0.013	5663	4.52	<0.01

[a]Random effect test statistics are based on the Z distribution; fixed effect test statistics are T's.
[b]0 = Employed, 1 = Non-employed.
[c]0 = Non-Hispanic whites, 1 = African Americans.
[d]1 = Alabama, 2 = Stony Brook.

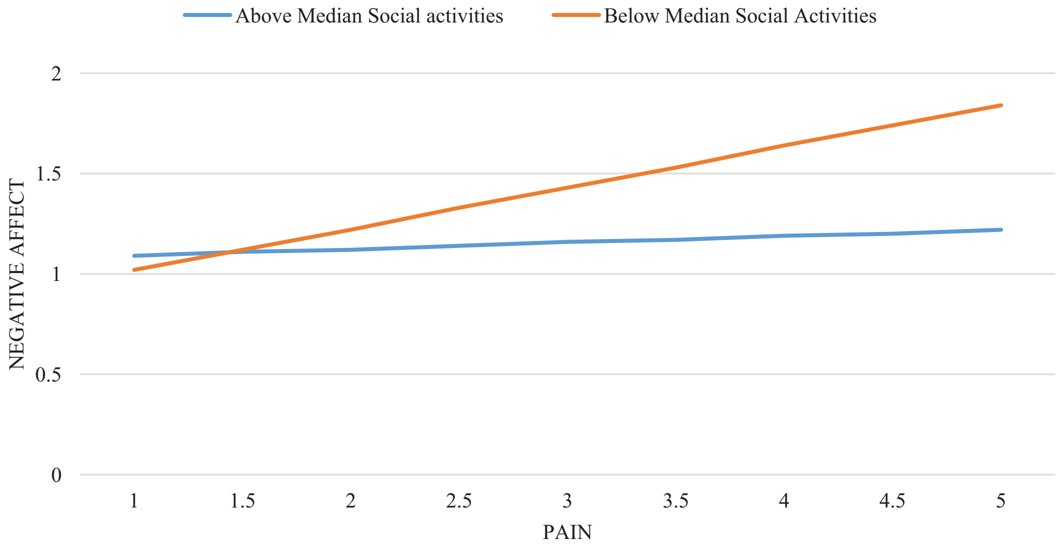

Figure 1. The effect of reported social activities on the relationship between pain and negative affect.

average ESM pain) and at Level 1 (mean-centered individual ESM pain score), and the covariates (age, sex, education level, employment status, income, race, study site, and baseline CESD depression level). Employment status was coded as either employed or unemployed. Income status was categorized according to income brackets: low income (<\$10,000–20,000), middle income (\$20,001–50,000), and high income (\$50,001–>70,001). Of note, negative interactions were incorporated into neutral interactions for analyses, given that total number of negative interactions across the utilized data set constituted only 1.0% of the data. While our primary outcome is ratio of positive to negative affect, we analyzed negative affect and positive affect separately, to see whether the observed patterns were different for these different types of affect, and to see whether we would observe the hypothesized interaction between social interactions and pain on negative affect, consistent with a buffering effect of social interactions (these interactions will be separately tested at both Level 2 and at Level 1) .

Results

In the initial, unadjusted models, we observed statistically significant and positive associations of affect ratio with both baseline social activities ($\beta = 0.49$, $p < .001$) and concurrent ESM social interactions,[1] especially when those interactions were coded as positive (for neutral, $\beta = 0.12$, $p < .001$; for positive, $\beta = 0.24$, $p < .05$); see Table 2. We next added the covariates, and both effects remained positive and significant. Other significant predictors in this model were CESD depression ($\beta = -0.04$, $p < .001$), subject-level average ESM pain ($\beta = -0.15$, $p < .04$), and concurrent ESM pain ($\beta = -0.14$, $p < .001$; see Table 2).

Next, we examined positive and negative affect separately (including all control variables). Again, we observed positive and significant associations between baseline social activities and concurrent ESM social interactions (see Table 3). For negative affect, we observed only a marginally significant negative association with baseline activities. However, this variable also yielded a significant negative interaction with subject average ESM pain ($\beta = -0.07$, $p < .01$), indicating that the association between pain and negative affect is smaller among respondents who reported more social interactions at baseline (see Figure 1). This interaction did not occur between concurrent (Level 1) pain rating and concurrent ESM (Level 1) social interactions; therefore, this term was not included in the final model depicted in Table 3.

Finally, we conducted a more traditional analysis using only baseline interview data, rather than the ESM momentary measures of experienced pain and mood. Specifically, we used baseline measures of overall pain, baseline social activities, and covariates to predict level of depression (CESD). Although we again observed a negative association between social activities and depression ($\beta = -0.31$, $p < .001$), we did not find an interaction between pain and social activities, such as was observed using the real-time assessments of symptoms.[2]

Discussion

The relationship between social interactions and the momentary perception of pain and mood in adults with OA of the knee was examined using an ESM protocol. Findings suggest that social interactions have a direct relationship with overall mood, and positive mood in particular. This effect was seen not just using a global measure for social activity patterns, but also within-day measures of social interactions. We also observed evidence consistent with a possible buffering effect, with social interactions reducing the association between pain and negative affect, though this interaction was observed only for the global measure of activity patterns, and not for the within-day measures. Analyses controlled for key demographic variables, including employment status and income, as well as baseline CESD depression scores.

Previous work has demonstrated that overall social activity involvement has the potential to impact psychological well-being, both directly, and through its capacity to buffer the effects of stressors, such as chronic pain, on mood (Bisschop et al., 2004; Blixen & Kippes, 1999; Bookwala et al., 2003; Cohen & Willis, 1985; Penninx et al., 1997). This study expands on these findings by including within-subject daily measures of these variables. The use of within-day measures aims to enhance the reliability of these self-reported measures and reduce the opportunity for recollection bias of symptoms, especially as they relate to specific events, particularly easily forgotten social interactions (Affleck et al., 1992; Eich et al., 1985; Erskine et al., 1990; Jenkins et al., 1979; Linton 1991). Further, momentary symptom and activity measures allow for a more accurate assessment of the way in which the variables in question interact and how they relate to traditional global measures. In the current data, the interaction between social activities and pain on negative emotion was observed only for the ESM measures of pain and affect; a parallel analysis using traditional recall based surveys did not yield this finding. The results of the current study reaffirm the importance of social contact for quality of life in the context of physical adversity, and add to the growing literature supporting the usefulness of ESM methods in chronic pain (May et al., 2018).

This study had several limitations, the most notable relating to the way in which our variable of focus was measured. There were no built-in prompts within the ESM protocol for assessing momentary social interactions. Interactions were coded based on extemporaneous comments made by respondents in regard to their overall activities during each call and since last check-in, which often did not include language identifying the quality of the interaction. Thus, more interactions were coded as 'neutral' than may have been reflective of reality, and many interactions were likely missed. The relationship between social interactions and perceptions of pain and mood may, therefore, be stronger than was established in this study, as many data points may have been missed due to lack of prompting. Conversely, the association may be weaker in reality, as subjects may have been more likely spontaneously to reference emotionally charged rather than neutral interactions, thereby weighting the sample towards events eliciting strong emotions. Further, the differential impact of in-person versus virtual communication, which has a growing impact on social connectedness as the population ages, was not delineated. An additional limitation is use of a convenience sample limited to the south- and northeast United States, which may not be representative of the global, or even national, population of adults with OA of the knee. This limitation was offset somewhat by the large and diverse sample, enhancing external generalizability of this study's findings. Third, while the fact that the baseline interview assessments of social interactions occurred prior to reported mood quality is consistent with a causal relationship in that direction, it is important to note that the temporal interplay between the key variables here—especially between affect and pain—is often more complex than a simple X leads to Y. We do not argue that our models capture the totality of this interplay, but rather suggest that social interactions are generally beneficial to emotional well-being in the context of chronic pain. Finally, out of consideration of participant burden, we conducted the ESM protocol for only one week. It is possible that longer observation periods (perhaps using less intensive methods) would capture less common but still important social interactions and thus yield additional evidence for their importance.

In conclusion, the results of this study suggest that social interactions have the potential not only to influence the mood of adults with OA of the knee, but to attenuate the negative impact chronic pain has on mood symptoms. This effect seems to be independent of overall social connectedness, suggesting a potential to influence quality of life through social activities in the short term, which could have a long-reaching impact on well-being in the long term. Future studies could expand the ESM assessment of the social environment, capturing more detail about the specific aspects of social interactions that are most helpful in promoting better quality of life in the context of experiencing chronic pain, perhaps yielding fruitful avenues for intervention.

Endnotes

1. As noted in the Methods section, the coding of social interactions included both an assessment of social activity immediately prior to the phone call ESM survey (reported here), and an assessment of social activity 'since the last phone call'. We also ran models using this second variable, and found substantively very similar results; therefore, in the interest of brevity we focus only on the 'immediately prior' social interactions variable from this point forward.
2. For negative affect, in addition to the Poisson model, we also tested the same model using negative binomial model and normal distribution assumptions. The coefficients changed only slightly across these approaches, and in each case the interaction between pain and social interactions was significant, suggesting that the result was not an artifact of the particular distribution chosen.

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