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# Social interactions in daily life: Within-person associations between momentary social experiences and psychological and physical health indicators

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## Abstract

It is well established that individuals who engage in more positive social interactions report a broad array of benefit relative to those with fewer positive social interactions. Yet less is known about how, within individuals, naturally occurring social interactions in daily life relate to momentary indicators of health (e.g., mood, psychological, and physiological stress). The current study used ecological momentary assessment (EMA) to examine these within-person relationships, as well as complementary between-person relationships, among 115 adults (75% female;  $M_{\text{age}} = 41.21$ ). Participants completed six EMA surveys per day for 3 days to report on whether they experienced any social

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interactions and whether the interactions were pleasant as well as on their mood, pain, tiredness, interest, and perceived stress; they also provided a salivary cortisol sample after each EMA survey. Multilevel modeling analyses showed that individuals felt more happiness and interest, and less sadness, tiredness, and pain, during moments when they were engaged in a social interaction versus when they were not. Individuals also reported less stress during more pleasant versus less pleasant social interactions. When examining between-person effects, we found evidence that people who gave more pleasant interactions generally reported more positive outcomes. This study presents evidence for intraindividual links between social interactions and momentary health indicators in daily life.

### **Keywords**

Daily health, ecological momentary assessment, social interactions

Social science examines a host of omnipresent and important social phenomena. Various subdisciplines within psychology, along with other fields including sociology and human development and family studies, examine myriad such phenomena, including prejudice, discrimination, and stigma (Devine, 1989; Goffman, 2009; Quillian, 2006); close relationships (Hofmann, Finkel, & Fitzsimons, 2015; La Greca & Harrison, 2005; Simpson, 1990); bias in hiring and jury decision (Bodenhausen, 1988; Tilcsik, 2011); social ostracism and bullying (e.g., Bansel, Davies, Laws, & Linnell, 2009; Bernstein, 2016; Olweus, 2013; Williams, 2007); social networking (Goel, Mason, & Watts, 2010; Mikami, Szvedo, Allen, Evans, & Hare, 2010); and a litany of other topics. Yet, some have critiqued that much research can be described as the study of button pushing or “finger movements” (e.g., Baumeister, Vohs, & Funder, 2007, pp. 397) whereas others have critiqued the use of current studies as far from studying actual behavior (e.g., Funder, 2006; Furr, 2009). Although field studies occur (e.g., Cialdini et al., 1976), they are not always the norm, particularly in certain subdisciplines of psychology.

Here, we use a method of data collection more commonly used in some fields (e.g., biobehavioral health) to examine complementary research questions—within the same person, how do social interactions and perceived qualities thereof relate to well-being indicators in daily life, and separately, are those who have more frequent and positive interactions also those who have more positive well-being indicators? We employ *ecological momentary assessment* (EMA) to answer these questions. We believe this method not only gets researchers closer to examining actual behavior, but that its method of analysis asks a fundamentally different question than do commonly used laboratory or cross-sectional designs.

### ***The importance of social interactions and how we’ve tended to examine them***

Social science has long understood that human beings are inherently social (e.g., Aronson, 1972). Belonging and social connectedness underlies successful functioning

(Baumeister & Leary, 1995) while also facilitating early childhood development (e.g., Runyan et al., 1998), improving both mental health (e.g., Myers, 1992) and overall health (e.g., House, Landis, & Umberson, 1988), and buffers against stress (e.g., Cohen, Sherrod, & Clark, 1986; Cohen & Wills, 1985). Much research has linked social interactions with a number of more positive short- and long-term psychological and health indicators (e.g., Berkman, Glass, Brissette, & Seeman, 2000; Kiecolt-Glaser et al., 1997), whereas social isolation has been linked to worsened health and well-being outcomes (e.g., Cacioppo & Hawkley, 2003; Lang & Baltes, 1997; Larson, Zuzanek, & Mannell, 1985; Park, 2004).

Although social interactions alone have been shown to be beneficial relative to isolation, positive features of social relationships (e.g., informational and emotional support, companionship) are beneficial for health (e.g., Smyth, Zawadzki, Santuzzi, & Filipkowski, 2014) and psychological well-being (e.g., reduced depression, Hays, Steffens, Flint, Bosworth, & George, 2001). In contrast, negative features of social interactions (e.g., social rejection, social evaluative threat, burden, and conflict) can have deleterious consequences (Filipkowski & Smyth, 2012; Gerber & Wheeler, 2009; Kiecolt-Glaser, Gouin, & Hantsoo, 2010; Marmot, 2004; Miller, 2001; Rook, 2001; Williams, 2007; Wirth, Bernstein, & LeRoy, 2015). It cannot be overstated then how important social interactions are to ourselves.

Although many theories focus on how relationships with close others impact us (Baumeister & Leary, 1995; Cohen & Wills, 1985; Maslow, 1968), interactions between people occur every day in which the preexisting closeness of the targets may be virtually non-existent (e.g., Wesselmann, Cardoso, Slater, & Williams, 2012), yet such interactions have received relatively little attention. Social interactions, in and of themselves, and the quality of those interactions are important to examine. For example, social impact theory (Latané, 1981) suggests that the effect other people have on a person is a function of a number of factors including the quality and immediacy of the interactions. Social impact occurs, and can only occur, when there is another actor with whom a target can interact. Thus, we assert that it is important to understand how social relationships impact ourselves for all relationships, even those with whom people are not necessarily close. Further, here we utilize EMA and a *within-person* approach, both of which we believe increase our ability to understand the nuances of how social interactions and their pleasantness affect people beyond other more traditional methods.

### *Within-person versus between-person approaches to studying social phenomena*

Generally, researchers have focused on between-person differences to provide evidence for “who” is likely to experience a certain outcome given a specific type of social interaction. This work is largely based on experimental laboratory studies that compare responses to a single social experience (e.g., Trier Social Stress Task, Kirschbaum, Pirke, & Hellhammer, 1993) or on cross-sectional data comparing differences among individuals who report different types of social interactions. These methods provide insight on how *different individuals* experience different outcomes (e.g., are individuals who experience mostly positive social interactions different from those who experience mostly negative interactions?).

A conceptually distinct approach examines how social interactions and different types of interactions relate to well-being indicators *within the same individuals*. For instance, how is a person's health or well-being different "when" that person experiences positive, as compared to negative, social interactions? This question helps identify how moment-to-moment differences in social interactions relate to changes in health-related factors across those moments.

This distinction is at the heart of why EMA is valuable for studying social phenomena; relationships between variables differ when applying a within- or between-person approach. For example, examining the relationship between exercise and heart rate, using a between-person approach, reveals that those people *who* exercise the most have lower resting heart rates (Fletcher et al., 1996). However, a within-person approach shows that *when* people are exercising, heart rates increase (Arai et al., 1989). Here, the opposite relationship exists between exercise and heart rate depending on the type of question asked. To assume that between-person and within-person level relationships are the same is an example of the ecological inference fallacy (i.e., inferring the nature of individuals from the group to which they belong); it is logically fallacious to assume that the magnitude or direction of a relationship between variables at the between-person level is the same as it is at the within-person level (Kramer, 1983). Social interactions generally, and particularly pleasant social interactions, result in more positive impacts on well-being at the between-person level, and it is reasonable to predict the same relationship should exist at the within-person level. Yet, this prediction must be tested using a within-person's approach. EMA provides repeated assessments of individuals' social interactions, allowing us to examine how health indicators vary when the same people are in different social interactions.

### *Social interactions in daily life*

Some work has indeed examined the links between social interactions and well-being using traditional daily diary methods. In such studies, participants are asked to report at the end of a day on events occurring during the day and often complete self-report measures related to those events. Reis's (2000) and others' work using daily diaries contributed significantly to the literature on a host of social phenomena (e.g., Belcher et al., 2011; Clark & Watson, 1988). Daily social events are related to greater and lower daily meaning (Machell, Kashdan, Short, & Nezlek, 2014), stressful social interactions result in negative affect (e.g., Peeters, Buunk, & Schaufeli, 1995), and positive global perceptions of social support predict lower negative mood and stress (e.g., Smyth et al., 2014).

Daily diary studies, although valuable, examine how people move in and out of days. Extending this approach, EMA provides more granular assessments. In such studies, participants carry with them a preprogrammed device prompting them to complete surveys multiple times per day over several days (see Smyth & Heron, 2012). Collecting repeated assessments from people's natural settings allows for capturing data from multiple social interactions per participant, increasing the heterogeneity in those events. EMA can largely circumvent retrospective recall biases (e.g., it is difficult to recall complex, global processes) as participants report on their momentary states as they occur in real time, presumably providing more accurate accounts of events and offering greater

ecological validity over more traditional methods assessing the importance of social interactions. Further, because EMA repeatedly samples individuals over time, we can compare the same individual under multiple conditions (e.g., each person serves as their own control). The first principle of social impact theory is “immediacy”; the more immediate the social forces (in both time and physical closeness), the larger the social impact those forces will have. EMA’s measurements are more *immediate* to the social interactions, allowing for better measurement and occurring within the same person, making for better generalizability.

Indeed, EMA has been used to relate social interactions and health. Negative social interactions predict more life stress, worsened affect (Rook, 2001, 2003), and increased indices of subclinical cardiovascular disease (Joseph, Kamarck, Muldoon, & Manuck, 2014). Being with more people was associated with feeling happier (Kashdan & Collins, 2010), and individual differences (e.g., social attachment) are further related to social interactions and consequences related to health and well-being (e.g., Gallo & Matthews, 2006; Hawkey, Preacher, & Cacioppo, 2007; Schwerdtfeger & Friedrich-Mai, 2009).

### *The current study*

The present study used EMA to examine how, *within individuals*, social interactions and perceived qualities thereof relate to well-being indicators in daily life. We additionally compare these within-person relationships to *between-person patterns* that examine a complementary question—are those who have more frequent and positive interactions on average also those who have more positive well-being indicators? Participants completed six EMA surveys daily for 3 days, reporting on whether they were engaged in a social interaction, its pleasantness, as well as their mood, tiredness, interest, pain, and stress; we chose these factors because they relate to social interactions research (e.g., tiredness, interest; see Twenge, Catanese, & Baumeister, 2003; pain, see Wirth, Turchan, Zimmerman, & Bernstein, 2014), they are responsive to environmental features and likely vary with social interactions (Smyth et al., 1998; Watson, 1988), and they relate to future well-being (e.g., Diener, Suh, Lucas, & Smith, 1999).

Salivary cortisol samples were also collected at each survey to provide an objective biological marker of stress in daily life (Smyth et al., 1998). Prior work reveals that cortisol increases when a person experiences stress and is thus believed to be a useful ambulatory biomarker of stressful experiences (e.g., Smyth et al., 1998), and research has found strong associations between cortisol and social interactions (e.g., social support buffers cortisol reactivity, Kirschbaum, Klauer, Filipp, & Hellhammer, 1995; less social connectedness relates to higher daily cortisol output, Grant, Hamer, & Steptoe, 2009; see also Ditzen, Hoppmann, & Klumb, 2008; Powers, Pietromonaco, Gunlicks, & Sayer, 2006).

We hypothesized that individuals would experience better psychological and physical health indicators—more positive mood and interest; less negative mood, tiredness, pain, and stress; and lower cortisol levels—when they were engaging in social interactions (versus no interactions; Hypothesis 1) and when social interactions were perceived as more pleasant (versus less pleasant; Hypothesis 2) and tested these hypotheses using both within- and between-person approaches.

## Method

### Participants

Recruitment occurred from the greater metropolitan area of a midsized city in the Northeast U.S. (see Zawadzki, Smyth, & Costigan, 2015). From an initial recruited pool of 122, 115 participants from the U.S. completed the baseline/intake session conducted at Syracuse University. All participants were (1) employed on weekdays with regular working hours, (2) not employed on weekends, (3) able to come into the research lab on a Wednesday evening and the following Monday, (4) fluent in English, (5) free of psychiatric therapy or drug treatment changes in the past 3 months, and (6) not pregnant. This data came from a larger study on work, leisure, and other daily experiences' relationship to indicators of well-being. Although participant restrictions limited participants to certain characteristics (e.g., no weekend employment), we believe those restrictions are not causally related to our findings (e.g., similar effects should occur among other populations).

Individuals' educational background varied considerably (9.7% had a high school [H.S.] degree or less, 41.2% had some college, and 49.1% had a baccalaureate degree) and incomes (20.7% made <US\$30,000, 52.3% made between US\$30,000 and US\$74,999, and 27.0% made  $\geq$ US\$75,000). Participants ranged in age from 19 to 63 ( $M = 41.12$ ;  $SD = 11.62$ ) and were predominantly female (74.8% women; 25.2% men). Most participants identified as White (74.8%) followed by Black (13.0%), Asian or Asian American (6.1%), and American Indian or Alaskan Native (1.7%); 4.3% people did not specify a race or indicated other. There was a roughly equal split between participants who were married or in a domestic partnership (50.4%) and single (49.6%).

### Procedure

Participants were recruited via cold calls (an online random number generator was used to identify names in a local phonebook) and via public listings on university e-mail news alerts. All eligible participants were invited to an initial lab visit on a Wednesday evening during which consent was obtained and baseline measures were completed. Participants were also trained on using an EMA device and salivettes (Sarstedt AG & Co, Nümbrecht, Germany) for providing saliva samples.

For the following 3 days (from Thursday to Saturday), all participants carried their EMA device (PalmPilot Z22; Palm, Inc., Sunnyvale, California, USA) during waking hours (as specified by participants prior to the study). Devices were programmed using a free, open-source software package called Experience Sampling Program (version 4.0) (<http://www.experience-sampling.org>) and emitted an auditory alarm at six semi-random intervals each day that prompted participants to complete a brief (approximately 2 min) survey and one saliva sample; each survey was automatically dated and time stamped, and participants recorded the time they completed the saliva sample on each salivette. To create the semi-random intervals, all waking hours were stratified into six equal parts; one assessment randomly occurred within each of the six intervals excluding the first and last 15 min of the interval. Participants returned the EMA device and salivettes, and they received US\$100 with an additional US\$20 award for completing >90% (at least 17 of 18) EMA surveys.

## Measures

**Baseline questionnaires.** Age, sex, race, marital status, income, and education level were assessed. Because of the planned statistical analyses, we reduced the number of levels across such factors: race was recoded as White or non-White; marital status as married (married or domestic partnership) or single (single, divorced, separated, or widowed); education as either H.S. or less or some college—with bachelor of arts or higher as the comparison condition; and income was recoded as either low income (less than US\$30,000) or middle income (US\$30,000–74,999)—with high income (more than US\$75,000) as the comparison condition. As an additional control for the cortisol analyses, participants indicated if they were currently taking oral contraceptives.

**Ecological momentary assessment.** We used EMA to assess self-reported social interactions and health in daily life. Reflecting high levels of compliance, 1729 total EMAs were collected across 108 participants with valid data (i.e., seven participants only completed the baseline assessment) resulting in an average of 16.01/18 assessments (approximately 89% completion rate) per person.

**Social interactions.** Engagement in social interactions was assessed with a yes/no response to the following item: “At the time of the prompt, were you having any social interaction?” Across all responses, participants were engaged in social interactions 48.5% of the time (range = 0–16,  $M = 7.82$ , and  $SD = 3.48$ ). If participants answered yes, they rated how pleasant the interaction they were having was on a 0 = *unpleasant* to 6 = *pleasant* scale ( $M = 4.93$ ;  $SD = 0.77$ ).<sup>1</sup>

**Mood, interest, tired, pain, and stress.** Mood was assessed by asking how happy and sad participants were feeling at the time of the prompt on a 0 = *not at all* to 6 = *very much* scale. Participants also indicated (using the same scale) how interested, in pain, tired, and stressed they were. Stress was also assessed with four items modified from the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983; Cohen & Williamson, 1991) to assess if participants were currently feeling stressed (e.g., “At the time of the prompt, did you feel difficulties piling up so you cannot overcome them?”). Participants responded using a 0 = *not at all* to 4 = *very much* scale. Across all observations, the four PSS items had acceptable reliability ( $\alpha = .68$ ).

**Additional controls.** To control for potential momentary influences on cortisol, participants indicated whether in the past 30 min they ingested caffeine, smoked cigarettes, or drank any alcoholic beverages, and whether they were eating or drinking at the time of prompt.

**Ambulatory cortisol.** Participants provided saliva samples for cortisol analysis using standard salivettes. These salivettes contain small synthetic material participants place in their mouth for 90 s and then placed back into the tube. Participants were given 18 prepared salivettes, separated into three bags each with six of the salivettes meant for each assessment day. At the end of each day, the bag of completed salivettes was placed in the freezer until the participant brought them back to the lab. All salivettes were sent to a lab (Dresden, Germany) that used standard methods to assay them for cortisol.



Given the non-normal distribution observed in cortisol, cortisol values were natural log-transformed prior to analysis. To ensure that participants completed the cortisol measures when instructed, we examined the time difference between the electronically time-stamped start of each EMA and the time participants recorded on the salivette when they completed the collection of saliva. Given that this time variable included both the time necessary to complete the EMA and saliva collection and to write the time on the salivette using potentially different clocks, we assumed that any assessments between 10 and 15 min would indicate high levels of compliance: 87.3% of samples were completed within 10 min of starting the EMA and 95.04% within 15 min.

### *Analytic plan*

The collected EMA data have a two-level structure, with observations (Level 1) nested within individuals (Level 2); thus, multilevel analyses were performed using the PROC MIXED command in SAS 9.3. Although all participants were administered the same study protocol, differing levels of compliance with the EMA and cortisol collection varied slightly across participants resulting in differing levels of missing data. Multilevel approaches are robust to missing data and are recommended for EMA data (Schwartz & Stone, 1998).

Our multilevel models examined two sets of effects. First, it tested between-person (Level 2) relationships examining whether those reporting more interactions on average (Hypothesis 1) and more pleasant interactions on average (Hypothesis 2) were those with better health and well-being than those with fewer and less pleasant interactions on average. Second, it tested within-person (Level 1) relationships examining whether momentary variation in social interactions (their occurrence—Hypothesis 1 and their pleasantness—Hypothesis 2) was associated with momentary variation in well-being outcomes relative to one's average levels. We tested each outcome in separate models.

For all models, we control for time-related variables (i.e., time of day and whether it was a workday or not) and participant demographics (i.e., sex, age, race, marital status, income, and education). Time of day was recoded into six 3-hr blocks, ranging from one to six, coinciding with the time window during which the six EMA prompts took place (i.e., higher values correspond to later times in the day). Age was entered as a continuous variable, whereas the rest of the demographics was entered as a series of dichotomous variables: sex (0 = *male*; 1 = *female*), race (0 = *non-White*; 1 = *White*), marital status (0 = *not married*; 1 = *married or in a domestic partnership*), low income (0 = *middle or high income*; 1 = *low income*), middle income (0 = *low or high income*; 1 = *middle income*), H.S. or less education (0 = *some college or college degree*; 1 = *H.S. or less*), and some college education (0 = *H.S. or less or college degree*; 1 = *some college*). Although these factors were not specific to our hypotheses, controlling for them allowed us to rule out potential time or person effects on mood, physical status, stress, and cortisol.

In addition, we made the following modeling decisions. First, we expected individuals to vary on their mean levels of momentary reports; thus, we allowed for random intercepts. We also explored potential random slopes for time of day or the momentary social interaction variables. These random slopes tested whether the effects of time or

interactions are different for individuals. In more than two thirds of the models in which they are included, the effects were not significant; moreover, including these random effects did not change the pattern of effects observed when they were not included. As a result, we adopted the more parsimonious models that just included a random intercept. Second, we assumed that each measurement was not independent but rather that measurements assessed closer in time would have a greater correlation than those assessed further apart. Thus, we specified a spatial power covariance structure with time modeled as the number of minutes that had elapsed since midnight of the first day of data collection. Such a covariance structure factors in that the measurements were not equally spaced apart and this structure is recommended for this type of data (Bolger & Laurenceau, 2013). Third, we person-mean centered our main predictors to examine the within-person effect of social interactions on the outcomes separately from the between-person effect (Bolger & Laurenceau, 2013). We included both the between-person and within-person versions of each social interaction variable to test each of these effects. Finally, to provide an estimate of effect size, we computed a pseudo  $r^2$  statistic that calculates the correlation for each person and each measurement between the observed value and the predicted values based on the model that is then squared (Singer & Willett, 2003). The resulting value measures how much of the variation in outcomes at each measurement can be explained by predictors at that measurement. We provide the pseudo  $r^2$  when the social interaction variables are and are not predictors to assess the added explanatory power they have in addition to the control variables.

We first compared outcomes when a person was engaged in a social interaction to when that same person was not engaged in an interaction (Hypothesis 1). Next, we used participants' perceptions of how pleasant the social interaction as the predictor (Hypothesis 2).

## **Results**

### *Preliminary analyses*

Using PROC NESTED in SAS, we explored the relationships between the outcomes reporting the variance component correlations at both the between- and within-person level. As can be seen in Table 1, the magnitude of relationships ranged from small to moderate, with somewhat stronger relationships at the between-person than within-person level. As such, we chose to analyze each outcome separately. Additionally, we fit a null model for each outcome in order to calculate the intraclass correlations, also reported in Table 1.

### *Hypothesis 1*

We first tested a series of models examining the effect of engaging in social interactions on mood, interest, tiredness, pain, stress, and cortisol (Hypothesis 1). We examined both the between-person (i.e., comparing people who have more interactions on average to people who have less) and within-person effects (i.e., comparing moments when an interaction occurred for a person to moments when that person did not have an

**Table 1.** Variance component correlations and variable statistics for daily health indicators.

	Happy	Sad	Interest	Tired	Pain	Stress	PSS	Cortisol
Variance component correlations								
Happy	—	-.47	.47	-.27	-.06	-.50	-.37	-.12
Sad	-.54	—	-.22	.29	.12	.47	.43	.06
Interest	.69	-.31	—	-.33	.09	-.22	-.23	-.06
Tired	-.45	.55	-.30	—	.16	.33	.27	-.07
Pain	.01	.09	-.12	.16	—	.12	.13	-.004
Stress	-.47	.71	-.27	.74	.15	—	.48	.09
PSS	-.56	.67	-.38	.54	.16	.71	—	.06
Cortisol	-.06	.06	-.01	.06	.04	.08	.13	—
Variable statistics								
Mean	4.35	0.73	3.87	2.12	0.60	1.30	1.81	0.53
SD	0.75	0.76	0.90	1.4	0.68	0.88	0.48	0.19
Possible range	0–6	0–6	0–6	0–6	0–6	0–6	0–4	—
Intraclass correlation	.28	.35	.28	.34	.37	.27	.43	.16

Note. The top portion of the table contains the variance component correlations across the daily health indicators in the study. Below the diagonal are the variance component correlations at the between-person level (i.e., across individuals). Above the diagonal are the variance component correlations at the within-person level (i.e., across all observations). The bottom portion of the table contains the variable statistics for the daily health indicators, including the mean, standard deviation, possible range, and intraclass correlation. PSS = Perceived Stress Scale.

interaction). All models controlled for time of day, whether it was a weekend day or not, and participant demographics, including age, sex, race, marital status, income, and education. Due to space concerns, only results related to fixed effects are discussed; additional model information (e.g., variance components) is available in each table. For the between-person effects (see Table 2), those who had more interactions on average reported being happier ( $p = .009$ ) than those having fewer interactions. No between-person effects were observed for sadness ( $p = .514$ ), interest ( $p = .148$ ), tiredness ( $p = .415$ ), pain ( $p = .869$ ), stress (stressed:  $p = .403$ ; PSS:  $p = .293$ ), and cortisol ( $p = .933$ ). For the within-person effects (see Table 2), when participants reported being engaged in social interactions, they reported more happiness ( $p < .001$ ), more interest ( $p < .001$ ), less tiredness ( $p < .001$ ), and less pain ( $p = .005$ ) than moments with no social interactions. No within-person effects for social interactions were observed for sadness ( $p = .121$ ), stress (stressed:  $p = .639$ ; PSS:  $p = .644$ ), and cortisol ( $p = .222$ ). For cortisol, we observed the expected effect of time of day (Nader, Chrousos, & Kino, 2010; Smyth et al., 1998), with cortisol decreasing throughout the day ( $b = -0.14$ ,  $SE = 0.01$ , and  $p < .001$ ). Thus, we captured normative cortisol processes.

## Hypothesis 2

Next, to supplement looking at social interactions regardless of valence, we examined whether the pleasantness of the social interaction predicted health and well-being (Hypothesis 2). We reran the same set of models used to test Hypothesis 1 but now replaced the dichotomous “engaged in a social interaction variable” with a variable

**Table 2.** Parameter estimates (standard errors) for having a social interaction on daily health indicators ( $n = 106$ ).

	Happy	Sad	Interest	Tired	Pain	Stress	PSS	Cortisol
<b>Fixed effects</b>								
Intercept	3.69*** (0.35)	1.39*** (0.36)	2.91*** (0.46)	2.06*** (0.56)	0.86* (0.39)	1.98*** (0.46)	2.25*** (0.25)	0.92*** (0.10)
Workday	-.14 <sup>+</sup> (.07)	.08 (.06)	-.06 (.07)	.003 (.10)	-.08 (.06)	.39*** (.07)	-.01 (.03)	-.04* (.02)
Time of day	.07*** (.02)	-.01 (.02)	.03 (.02)	.23*** (.03)	.04* (.02)	-.06* (.02)	.01 (.01)	-.14*** (.01)
Sex	-.19 (.16)	.12 (.16)	.06 (.21)	.21 (.25)	-.10 (.18)	.02 (.21)	-.08 (.11)	-.001 (.05)
Age	.01 <sup>+</sup> (.01)	-.01* (.01)	.02* (.01)	-.02 <sup>+</sup> (.01)	-.005 (.01)	-.01 <sup>+</sup> (.01)	-.003 (.004)	.0002 (.002)
Race	-.44*** (.15)	.28 <sup>+</sup> (.15)	-.51* (.20)	.87*** (.24)	.04 (.17)	.59*** (.20)	.20 <sup>+</sup> (.11)	-.03 (.04)
Married	.10 (.17)	-.40* (.17)	.26 (.22)	-.36 (.27)	-.10 (.19)	-.39 <sup>+</sup> (.22)	-.26* (.12)	.01 (.05)
Low income	.68*** (.23)	-.69*** (.24)	.95*** (.31)	-.94* (.38)	-.30 (.27)	.89*** (.31)	-.42* (.17)	.04 (.07)
Middle income	.13 (.16)	-.05 (.16)	.16 (.21)	-.07 (.26)	-.06 (.18)	-.25 (.21)	-.17 (.12)	-.03 (.05)
H.S. or less	.38 <sup>+</sup> (.22)	-.15 (.23)	.03 (.29)	.44 (.36)	.41 (.25)	-.02 (.29)	-.05 (.16)	.01 (.07)
Some college	-.12 (.14)	-.005 (.14)	-.50*** (.18)	.10 (.22)	.18 (.16)	-.13 (.18)	-.04 (.10)	-.001 (.04)
Social interaction (between-person)	.81*** (.31)	-.21 (.33)	.60 (.42)	-.41 (.51)	-.06 (.36)	-.35 (.41)	-.24 (.23)	.01 (.09)
Social interaction (within-person)	.37*** (.06)	-.08 (.05)	.50*** (.07)	-.39*** (.07)	-.11** (.04)	.05 (.07)	-.01 (.03)	.02 (.02)
<b>Variance components</b>								
Initial status	.26*** (.07)	.35*** (.06)	.58*** (.10)	.81*** (.15)	.43*** (.07)	.59*** (.10)	.20*** (.03)	.03*** (.005)
Autocorrelation	1.00*** (0.001)	0.99*** (0.003)	0.98*** (0.003)	0.99*** (0.001)	0.99*** (0.001)	0.38 (4.40)	0.91*** (0.00)	0.99*** (0.002)
Residual	0.93*** (0.07)	0.62*** (0.12)	0.40*** (0.10)	0.50*** (0.14)	0.10*** (0.02)	0.80 (11.22)	0.28*** (0.01)	0.02*** (0.01)
<b>Model statistics</b>								
Pseudo $r^2$ without interactions	.077	.074	.065	.107	.021	.073	.057	.272
Pseudo $r^2$ with interactions	.105	.076	.090	.119	.023	.075	.059	.272

Note. Cortisol is log-transformed. Workday (0 = nonwork day; 1 = work day), sex (0 = male; 1 = female), race (0 = non-White; 1 = White), married (0 = not married; 1 = married or in a domestic partnership), low income (0 = middle or high income; 1 = low income), middle income (0 = low or high income; 1 = middle income), H.S. or less (0 = some college or college degree; 1 = H.S. or less), and some college (0 = H.S. or less or college degree; 1 = some college) are binary variables. Time of day is coded to indicate the EMA interval ranging from 0 to 5. Age is continuous. Social interaction (between-person) is the person-mean of social interactions representing the proportion of all occasions in which an interaction occurred for each person. Social interaction (within-person) is a binary variable indicating if an interaction occurred at each measurement occasion (0 = no interaction; 1 = interaction) that has been person-mean centered (momentary value—person-mean). PSS = Perceived Stress Scale; EMA = ecological momentary assessment; H.S. = high school.

<sup>+</sup> $p < .10$ , \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

measuring how pleasant the interaction was perceived (as such, these analyses were constricted to only those moments when an interaction took place). Again, we tested for between-person and within-person effects. For the between-person effects, those who had more pleasant interactions on average reported more happiness ( $p < .001$ ) and interest ( $p < .001$ ) and less sadness ( $p < .001$ ) and stress (stressed:  $p < .001$ ; PSS:  $p < .001$ ), relative to people who had less pleasant interactions on average. No significant between-person effects were observed for tiredness ( $p = .143$ ), pain ( $p = .289$ ), and cortisol ( $p = .895$ ). For the within-person effects, when participants rated interactions as more pleasant than is typical for them (see Table 3), they reported more happiness and interest ( $ps < .001$ ), and less sadness ( $p < .001$ ), tiredness ( $p < .001$ ), pain ( $p = .024$ ), and stress (stressed and PSS:  $ps < .001$ ), relative to when they rated interactions as less pleasant than typical. No within-person effects were observed for cortisol ( $p = .171$ ).<sup>2,3</sup>

## Discussion

Prior work has shown that social interactions and their quality have important relationships on well-being, but this work has largely used between-person approaches. Here, we primarily examined a within-person approach and used EMA to investigate differences in individuals' well-being during moments with versus without social interactions and along varying degrees of pleasantness. We were able to compare this to a between-person approach, previously revealing that more socially engaged individuals have more positive well-being. From this, we found more happiness and interest as well as less sadness, tiredness, and pain during moments when participants were engaged in social interactions compared to moments when they were not. Additionally, we found that positive interactions in daily life were associated with more positive outcome. Of note, the addition of "positive social interactions" added significantly to the amount of variability our model explained (adding almost 15% to the model's explanatory power).

We also examined between-person effects and found evidence that people who gave more pleasant interactions generally reported more positive outcomes. This confirms what we expected based on prior literature, using between-person effects to examine the impact of social interactions on psychological well-being. Importantly, these between-person effects are complementary to the consistent momentary effects we find on a within-person basis.

Documenting our predicted effects in natural life, outside of highly controlled experimental manipulations, suggests that these relationships are important and generalize beyond laboratory contexts. EMA allows for ecologically valid tests of the association between naturally occurring social interactions and momentary health indicators, and of mechanistic inferences about how social interactions in daily life may lead to long-term health outcomes. We included multiple outcomes related to psychological well-being and health in our study, showing our findings further generalize across dependent variables. We also extended the effects to a noncollege student population (i.e., full-time working adults) and measured the results in the moment rather than via retrospective recall. In an era of fierce concern regarding the replicability and validity of laboratory findings (e.g., Many Labs; Klein et al., 2015), EMA provides an alternative and powerful test of the generalizability of core laboratory findings to "real-life."

**Table 3.** Parameter estimates (standard errors) for pleasantness of social interactions on daily health indicators ( $n = 106$ ).

	Happy	Sad	Interest	Tired	Pain	Stress	PSS	Cortisol
<b>Fixed effects</b>								
Intercept	1.13** (0.42)	3.03*** (0.51)	0.40 (0.73)	2.47** (0.93)	1.32* (0.67)	4.32*** (0.72)	3.79*** (0.38)	0.98*** (0.18)
Workday	-.10 (.07)	.04 (.08)	-.02 (.09)	.07 (.13)	-.10 (.07)	.25** (.09)	-.02 (.04)	-.05* (.02)
Time of day	.06* (.02)	-.01 (.02)	-.01 (.03)	.29*** (.04)	.04 <sup>+</sup> (.02)	-.07* (.03)	.01 (.01)	-.13*** (.01)
Sex	-.07 (.12)	.04 (.15)	.23 (.21)	.12 (.27)	-.19 (.19)	-.17 (.20)	-.13 (.11)	-.06 (.05)
Age	.004 (.004)	-.01 <sup>+</sup> (.01)	.02** (.01)	-.02 (.01)	-.002 (.01)	-.01 (.01)	-.0001 (.004)	.0004 (.002)
Race	-.10 (.12)	.07 (.15)	-.07 (.21)	.63* (.26)	-.06 (.19)	.36 <sup>+</sup> (.20)	.11 (.11)	-.04 (.05)
Married	-.04 (.12)	-.43** (.15)	.10 (.21)	-.17 (.27)	-.04 (.20)	-.16 (.21)	-.29 (.11)	.03 (.05)
Low income	.40* (.18)	-.41 <sup>+</sup> (.22)	.66* (.32)	-.61 (.41)	-.18 (.30)	-.39 (.32)	-.26 (.17)	.04 (.08)
Middle income	.01 (.12)	.09 (.15)	-.07 (.21)	.01 (.27)	-.02 (.20)	-.10 (.21)	-.06 (.11)	-.03 (.05)
H.S. or less	.59*** (.17)	-.14 (.21)	.15 (.30)	.47 (.38)	.45 (.28)	-.41 (.29)	-.001 (.16)	-.06 (.07)
Some college	-.05 (.10)	.04 (.13)	-.45* (.18)	.09 (.23)	.12 (.17)	-.24 (.18)	-.02 (.09)	-.01 (.04)
Interaction pleasantness (between-person)	.64*** (.07)	-.38*** (.08)	.55*** (.12)	-.22 (.15)	-.11 (.11)	-.48*** (.12)	-.36*** (.06)	-.004 (.03)
Interaction pleasantness (within-person)	.52*** (.03)	-.19*** (.03)	.31*** (.04)	-.16*** (.04)	-.05* (.02)	-.53*** (.04)	-.12*** (.02)	-.01 (.01)
<b>Variance components</b>								
Initial status	.09** (.03)	.19*** (.05)	.52*** (.10)	.72*** (.17)	.49*** (.09)	.46*** (.10)	.15*** (.03)	.03*** (.01)
Autocorrelation	1.00*** (0.002)	0.99*** (0.004)	0.97*** (0.01)	0.99*** (0.001)	0.99*** (0.002)	-.06 (11.09)	0.90*** (0.00)	0.99*** (0.003)
Residual	0.59*** (0.10)	0.51*** (0.15)	0.15* (0.09)	0.65*** (0.19)	0.09* (0.04)	0.39 (205.64)	0.26*** (0.01)	0.02*** (0.01)
<b>Model statistics</b>								
Pseudo $r^2$ without pleasantness	.078	.074	.065	.107	.021	.073	.057	.272
Pseudo $r^2$ with pleasantness	.423	.145	.234	.125	.032	.232	.215	.284

Note. Cortisol is log-transformed. Workday (0 = nonwork day; 1 = work day), sex (0 = male; 1 = female), race (0 = non-White; 1 = White), married (0 = not married; 1 = married or in a domestic partnership); low income (0 = middle or high income; 1 = low income), middle income (0 = low or high income; 1 = middle income), H.S. or less (0 = some college or college degree; 1 = H.S. or less), and some college (0 = H.S. or less or college degree; 1 = some college) are binary variables. Time of day is coded to indicate the EMA interval ranging from 0 to 5. Age is continuous. Interaction pleasantness (between-person) is the person-mean of the pleasantness ratings for all interactions. Interaction pleasantness (within-person) is a variable indicating the momentary pleasantness at each measurement occasion (0 = unpleasant to 6 = pleasant scale) that has been person-mean centered (momentary value - person-mean). PSS = Perceived Stress Scale; EMA = ecological momentary assessment; H.S. = high school.

<sup>+</sup> $p < .10$ ; \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

Moreover, the current study showed effects across a wide range of self-report measures. Individually, each measure is valuable and connects with prior work; collectively, evidence linking social interactions (and their features) to various measures of well-being speaks to both the breadth of these findings and the likely connection to long-term well-being and health outcomes.

To be clear, we do not believe the within-person question is an inherently better or more interesting than the between-person question nor do we believe that EMA is necessarily superior to laboratory or cross-sectional approaches. As noted, within-person questions and EMA methods are a different approach to examining phenomena and provide answers to fundamentally different questions than between-person approaches (see Molenaar & Campbell, 2009). As such, we see EMA (and other within-person approaches) as complementary to other methods. It is essential to remember that a relationship at one level (within or between) is independent from any relationship at the other level (Molenaar & Campbell, 2009). Within-person and between-person approaches can yield results that are the same, unrelated, or opposite in the nature of the relationships observed. That our results appear similar to the results of between-person studies is supportive of the existing theories but does not reduce the importance of these findings; until within-person approaches are used to study social phenomena, there is no reason to be confident that the known direction and magnitude of relationships between variables found using between-person approaches will be the same for within-person questions. If we think back to the relationship between exercise and heart rate discussed in the introduction, that the same variables could show different relationships based on the method of analysis highlights the importance of using multiple methods and underscores that these approaches address fundamentally different questions.

There are several unanswered questions that present promising avenues for future research. For instance, while our study occurred over only 3 days, future research may use longer assessment periods to allow for comparisons of contextual factors (e.g., relationship to interaction partner, whether stressful events preceded the interaction, the relative ability to escape the situation) related to within-person differences in responses to social interactions. Also, we primarily examined whether social interactions were occurring and their pleasantness; although these are reasonable places to start, we recognize that much more can be done here. Additional features of social interactions may have implications for momentary health indicators in daily life. It is possible that a discrepancy between the desired versus achieved level of social interactions (e.g., wanting less social interactions but receiving it; Burger, 1995; wanting more individuals to count on than are available; Antonucci, Akiyama, & Lansford, 1998) may result in negative consequences (e.g., Altman, 1975). Social impact theory, in particular, suggests that as the number of social interaction partners increase, their power should increase too; while the theory clearly states that the largest change in social impact happens when moving from 0 social forces to 1 (a claim which supports our initial investigation into how social interactions of *any* kind impact health and well-being), understanding how increasing the number of social forces interacts with the quality of the social interaction on health outcomes would be valuable to examine. Given the incredible importance of belonging to our lives (Baumeister & Leary, 1995), it would be of interest to examine

how different facets of such social relationships moderate our effects and how our method of analysis can be applied to different research questions about our relationships.

We also did not find any effect of having a social interaction (or not) on stress. We believe this may be due to the way we assessed the experience of a social interaction—our assessment of this factor was dichotomous (yes or no social interaction). Although we found that, generally, having a social interaction was experienced positively, the variability in said interactions may have been obscured enough so as to obfuscate any impact on stress (e.g., some interactions may have been restful while others demanded effort, and some interactions were felt as positive and engaging, whereas others may have been explicitly stressful). Future work should clarify the types of interactions and how stressful those interactions were.

Although these results provide interesting information on the within-person time-varying association between social interactions and mood, it is important that subsequent research examine the bidirectionality (or other patterns) of the relationship between social interactions and mood. Although we largely interpret our findings to suggest that social interactions led to impacts on mood (based on the existing literature consistent with this view), it is an interesting question as to whether mood states predict social interactions (e.g., does positive mood lead us to seek out others). Future work might benefit by utilizing a denser assessment schedule that measures more moments throughout the day compared to the present study. With greater density, one could test lagged models in order to see how a variable at one moment predicts another at a subsequent occasion; although not a test of causality, it does provide stronger evidence of temporal precedence of associations (and/or other patterns, such as reciprocal relationships).

Our null findings for cortisol responses could be due to measurement timing and the activation of cortisol. Generally, the peak level of cortisol is observed approximately 20 min after its stimulus (Kirschbaum & Hellhammer, 1994). In this study, the EMA sampling protocol assessed social experiences shortly followed by saliva sampling for cortisol, thus potentially underestimating the association of social interactions and cortisol response (assuming that most social interactions captured by EMA had not been already occurring for  $\geq 20$  min). This is a somewhat common aspect of collecting cortisol using an EMA design, largely to reduce burden of a delayed saliva sample (i.e., adding a break between the EMA and the saliva collection significantly increases the burden placed on participants, requiring two disruptions in their daily lives). Additionally, social interactions captured at a sampling moment may have been ongoing for some time. For example, if a participant had been in a social interaction for 15 min and was signaled, by the time they completed the EMA and finish the saliva collection, they would only then be approaching the optimal time line for observing a cortisol response. Of course, not all social interactions will be of equal duration and signals may come at different points during the interaction. Thus, there is considerable unanticipated variability on the underlying timing of the onset of the social interaction and the salivary cortisol assessment. Thus, overall, this first attempt to capture cortisol responses to social interactions may have been suboptimal, and we encourage future research on this topic to carefully consider these complexities when designing and implementing such sampling.

Measuring and modeling different features of social interactions may also improve the explained variance in the daily health indicators. In general, the pseudo  $r^2$  values



were about 10% but ranged anywhere from 3% to 30%. Although in some cases these values appear low, we note that this reflects the effect on the daily health indicators for a given moment; the cumulative effect of social interactions may be considerably more impactful. Also, this level of explained variance is typical of EMA studies. Nonetheless, these values also indicate that there are other important predictors of how daily health indicators change over time that we did not assess in this study. Future work should explore additional time-varying predictors in the model related to other dimensions of social interactions (e.g., social evaluative threat; Smith, Birmingham, & Uchino, 2012) or contextual factors (e.g., one's location; Damaske, Smyth, & Zawadzki, 2014).

## Conclusion

Prior research has shown that interactions characterized by more frequent and more positive social interactions also experience better outcomes. Using EMA, we build on this knowledge in two important ways: (1) extending this research to encompass naturally occurring social interactions in people's environment and (2) understanding the within-person associations of social interactions to psychological well-being. Using EMA beyond the lab complements and extends prior work by directly testing associations theorized to be occurring in momentary experiences; social interactions are potent influences on health and well-being in daily life.

Using a within-person approach, we compared individuals to themselves during moments when they were engaged in social interactions versus moments of no social interaction, while also examining unique contributions of the qualities of social interactions (i.e., pleasantness). Given the findings that social interactions were fairly robust in their associations with well-being indicators, interventions that encourage individuals to focus on social connections or increase social support and support opportunities could have important implications for well-being (e.g., Denson, Spanovic, & Miller, 2009; Dickerson, Gable, Irwin, Aziz, & Kemeny, 2009). Future work can extend our findings in the development and evaluation of additional interventions, using social relationships to impact our behaviors.

Social belonging is a core need for human beings (Baumeister & Leary, 1995), and the connections we form with others are integral to our sense of self and identity, our health—both physical and mental—our development, our family dynamics, and our group and system level behaviors. Understanding relationships—not only with close others but in all relationship interactions—seems key to understanding and expanding our knowledge about myriad social phenomena. EMA allows us to examine the social processes in specific contexts outside the lab while studying actual and ongoing social behavior, rather than relying on experiments lacking ecological validity, examining existing data sets, or collecting cross-sectional studies. Further, extensions of this within-person approach help us answer questions about when people behave in different ways as opposed to what types of people behave differently. Studies of family dynamics, adolescent and adult development, clinical psychology, and even sociological studies of health, prejudice, and other topics could all benefit from both the procedures employed here as well as the use of within-person analyses. We encourage the broader use of within-person approaches to supplement more commonly used designs.

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## Notes

1. In addition to assessing whether participants were experiencing a social interaction and its pleasantness, participants also reported whether or not they were “treated unfairly” and/or felt “left out/ignored” during the interaction. We had initially planned on conducting a priori analysis to examine how social exclusion and being treated unfairly potentially differed in terms of their impact on psychological well-being. Base rates of these experience were low, however: Across all interactions ( $n = 899$ ), participants reported 24 moments of being treated unfair, 16 moments of being ignored, and 4 moments of being both treated unfair and ignored. These events accounted for 4.89% of all social interactions and were reported by 25.2% of participants. Given the low base rates, results for these variables are presented briefly in notes and are available in more detail upon request.
2. We also explored whether feeling left out/ignored during a social interaction predicted health and well-being. We reran similar models used to test Hypothesis 2 but replaced pleasantness of the interaction with feeling ignored or not variable. For the between-person effects, people who were ignored more on average reported less happiness ( $b = -3.17$ ,  $SE = 1.07$ , and  $p = .003$ ), more sadness ( $b = 2.89$ ,  $SE = 1.03$ , and  $p = .005$ ), more stress (stressed:  $b = 4.20$ ,  $SE = 1.41$ , and  $p = .003$ ; Perceived Stress Scale [PSS]:  $b = 2.41$ ,  $SE = 0.80$ , and  $p = .003$ ), and more cortisol ( $b = 0.72$ ,  $SE = 0.34$ , and  $p = .033$ ) than people who were less ignored on average. No effect was observed for interest ( $b = -0.35$ ,  $SE = 1.53$ , and  $p < .819$ ), tiredness ( $b = 0.44$ ,  $SE = 1.81$ , and  $p = .810$ ), or pain ( $b = 0.72$ ,  $SE = 1.29$ , and  $p = .580$ ). For the within-person effects, when participants had social interactions that made them feel left out or ignored, they reported less happiness ( $b = -1.94$ ,  $SE = 0.25$ , and  $p < .001$ ), more sadness ( $b = 1.01$ ,  $SE = 0.22$ , and  $p < .001$ ), less interest ( $b = -0.78$ ,  $SE = 0.27$ , and  $p = .005$ ), more stress (stressed:  $b = 2.13$ ,  $SE = 0.32$ , and  $p < .001$ ; PSS:  $b = 0.59$ ,  $SE = 0.13$ , and  $p < .001$ ), and marginally more cortisol ( $b = 0.12$ ,  $SE = 0.07$ , and  $p = .076$ ), compared to when they had social interactions that did not make them feel left out or ignored. No effect was observed for tiredness ( $b = 0.51$ ,  $SE = 0.32$ , and  $p = .106$ ) or pain ( $b = 0.04$ ,  $SE = 0.17$ , and  $p = .831$ ).

We also examined, separately, when a social interaction made a participant feel as though they were treated unfairly. We replaced the ignored variable in the analyses above with being treated unfairly or not variable. For the between-person effects, no significant effects were observed: happiness ( $b = -1.35$ ,  $SE = 0.85$ , and  $p = .115$ ), sadness ( $b = 0.40$ ,  $SE = 0.83$ , and  $p = .632$ ), interest ( $b = -0.55$ ,  $SE = 1.22$ , and  $p = .652$ ), tiredness ( $b = -1.14$ ,  $SE = 1.41$ , and  $p = .417$ ), pain ( $b = -0.47$ ,  $SE = 1.03$ , and  $p = .646$ ), stress (stressed:  $b = 0.69$ ,  $SE = 1.17$ , and  $p = .556$ ; PSS:  $b = 0.31$ ,  $SE = 0.68$ , and  $p = .645$ ), and cortisol ( $b = -0.10$ ,  $SE = 0.27$ , and  $p = .711$ ). For the within-person effects, when participants had social interactions that made them feel they were being treated unfairly, they reported less happiness ( $b = -1.10$ ,  $SE = 0.24$ , and  $p < .001$ ), more sadness ( $b = 0.70$ ,  $SE = 0.21$ , and  $p < .001$ ), marginally less interest ( $b = -0.46$ ,  $SE = 0.26$ , and  $p = .080$ ), and more stress (stressed:  $b = 1.62$ ,  $SE = 0.31$ , and  $p < .001$ ); however, no significant effects

were observed for tired ( $b = 0.15$ ,  $SE = 0.31$ , and  $p = .641$ ), pain ( $b = 0.001$ ,  $SE = 0.17$ , and  $p = .993$ ), PSS ( $b = 0.14$ ,  $SE = 0.12$ , and  $p = .246$ ), or cortisol ( $b = 0.0002$ ,  $SE = 0.07$ , and  $p = .997$ ).

When individuals felt left out/ignored during a social interaction, they experienced more sadness and stress, less happiness and interest, and *higher* cortisol levels compared to when not left out. Moreover, being excluded was associated with different momentary health states than was being treated unfairly. Yet, we urge caution in interpreting results. Less than 5% of social interactions were reported as negative in some manner (either unfair or ignored), and 74.8% of participants did not report experiencing any type of negative social interaction. On the one hand, these numbers may suggest that social exclusion experiences may be less frequent than previously assumed (e.g., Williams, 2001). However infrequent, these events may have meaningful effects when they do occur. On the other hand, the low frequency of these events, and that only a subset of the population reported them, suggests limits to generalizability. In order to better understand the effect of negative events during social interactions and to better test the generalizability of these effects, future work may consider longer assessment intervals, examining target populations that may experience higher base rates of relevant social interactions (e.g., school-aged children), and personality characteristics that might attune people to negative social interactions (e.g., rejection sensitivity; Downey & Feldman, 1996). Finally, we found that people who tended to have more interactions in which they felt ignored also reported more negative interactions; no between-person effects were found for those who reported being treated unfairly more on average. But even when accounting for between-person effects, we still find the momentary effects on which we reported above. This suggests that momentary effects are not explained as a function of dispositional differences in the types of people who experience negative social interactions.

3. Given the potential sensitivity of cortisol to be influenced by the ingestion of drugs and other chemicals, we reran all analyses controlling for whether or not the participant was taking oral contraceptives (assessed at baseline) and whether or not participants had ingested caffeine, smoked a cigarette, drank alcohol, and/or eaten or drunken around the time of collecting each saliva sample (measured at each ecological momentary assessment). A similar patterns of results emerged when including these variables as additional controls: neither social interactions (Hypothesis 1: between-person,  $b = -0.003$ ,  $SE = 0.10$ , and  $p = .978$ ; within-person,  $b = 0.02$ ,  $SE = 0.02$ , and  $p = .306$ ) nor quality of social interactions (Hypothesis 2: between-person,  $b = -0.01$ ,  $SE = 0.03$ , and  $p = .711$ ; within-person,  $b = -0.02$ ,  $SE = 0.01$ , and  $p = .104$ ) were significantly related to cortisol.

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