The associations of intimacy and sexuality in daily life: Temporal dynamics and gender effects within romantic relationships

Jacques van Lankveld¹, Nele Jacobs¹, Viviane Thewissen¹, Marieke Dewitte², and Peter Verboon¹

Abstract
The experience of emotional intimacy is assumed to play a particularly large role in maintaining sexual desire and partnered sexual activity in romantic relationships of longer duration. It is unclear whether the effect of intimacy on sexual contact between partners is direct or indirect, via its impact on sexual desire. Baumeister and Bratslavsky suggested that a certain increment in emotional intimacy causes a greater increment in sexual desire in men than in women. In the present study, we aimed to test the mediating role of sexual desire between perceived intimacy and sexual partner interaction and the gender effect as hypothesized by Baumeister and Bratslavsky. Experience sampling methodology in the participant’s natural environment was used. At 10 quasi-random moments per day, during 7 consecutive days, 134 participants reported their feelings of emotional intimacy, sexual desire, and sexual activity. The direct effect of intimacy on sexual partner interaction was not significant, but an indirect effect via sexual desire was observed. The strength of the association between intimacy and sexual desire diminished over time, from the strongest effect when intimacy, sexual desire, and sexual activity were measured simultaneously to a very small, but significant effect at an average time lag

¹ Open Universiteit of the Netherlands, the Netherlands
² Maastricht University, the Netherlands

Corresponding author:
Jacques van Lankveld, Faculty of Psychology and Educational Science, Open Universiteit of the Netherlands, Valkenburgerweg 177, Heerlen, 6401 DL, the Netherlands.
Email: jacques.vanlankveld@ou.nl
of 3 hr. At still larger time gaps, no effects were found. Men reported a higher average level of sexual desire than women, but the strength of the link between (increases in) intimacy and sexual desire was not different between the genders. The present findings suggest that in both male and female partners in romantic, long-term relationships, higher levels of intimacy are associated with higher sexual desire, which is, in turn, associated with higher odds for partnered sexual activity to occur. The temporal association of increasing intimacy and subsequent sexual desire appears not to be different in women and men.

Keywords
Ecological validity, experience sampling methodology, sexual desire, sexual interaction

Introduction
A satisfying romantic relationship is important for both partners’ quality of life and health status (Hinchliff & Gott, 2004; Hook, Gerstein, Detterich, & Gridley, 2003; Impett, Finkel, Strachman, & Gable, 2008). Major contributions to relationship quality are made by the couple’s emotional intimacy, as it helps to buffer daily stress and thus enhances partners’ well-being and adjustment (Levine, 1991; Prager, 1997; Yoo, Bartle-Haring, Day, & Gangamma, 2014), as well as their satisfaction with their sexual relationship (Hinchliff & Gott, 2004; Impett et al., 2008; Impett, Muise, & Peragine, 2014; Klusmann, 2002; Yoo et al., 2014). Intimacy is hypothesized to serve both as a trigger for sexual desire and as a reward resulting from the experience of sexual arousal and—in particular—of orgasm (Basson, 2000). In the present study, we aimed to investigate the temporal dynamics of the associations between emotional intimacy, sexual desire, and partnered sexual activity during the day and across multiple days, using high-frequent ecological momentary assessment methodology. We also investigated possible gender differences in these associations.

Multiple definitions of intimacy are found in the literature (e.g., Reis & Patrick, 1996; Reis & Shaver, 1988; Sternberg, 1986). In the present study, we closely follow Sternberg’s (1986) definition of intimacy as the experience of strong feelings of closeness, connectedness, and bonding.

Cross-sectional, longitudinal, and experimental studies provided empirical support for the hypothesis that experiencing emotional intimacy plays a major role in maintaining sexual desire and partnered sexual activity in relationships of longer duration (Birnbaum, Cohen, & Wertheimer, 2007; Bodenmann, Pihet, & Kayser, 2006; Klusmann, 2002; Stephenson & Meston, 2010). In a prospective daily diary study, female as well as male partners’ perceived intimacy was associated with higher odds that partnered sexual activity occurred (Dewitte, van Lankveld, Vandenberghhe, & Loeys, 2015). However, the connections between intimacy, sexual desire, and sexual interaction have thus far not been investigated extensively. Sexual desire was found to mediate the link between intimacy as an approach goal and sexual satisfaction (Muise, Impett, & Desmarais, 2013), but whether sexual desire also mediates the association of intimacy and
sexual contact between partners is unclear. Birnbaum and colleagues conducted a series of experimental studies and found that sexual desire increased when the partner was perceived as or was actually exhibiting higher emotional responsiveness, which is considered a building block of couple intimacy (Birnbaum et al., 2016). This effect was found stronger in women than in men. In the current study, we aimed to investigate the temporal dynamics of the links between intimacy, sexual desire, and partnered sexual activity by collecting data during multiple assessments per day.

The intimacy–sex link in long-term couples is also theorized within the field of sexology to be expressed differently in women and men (Basson, 2000; Schnarch, 1997). According to these models, women’s sexual desire is more likely to emerge once they feel emotionally intimate with their partner, whereas among men, intimacy and sexual desire have a weaker connection and sexual desire is more biologically driven (Basson, 2000, p. 54). In ongoing romantic relationships of longer duration, spontaneous and proactive sexual desire are considered to be more characteristic of male than of female partners (Basson, 2000; Štulhofer, Carvalheira, & Traen, 2013). Evolutionary psychology theorists, on the other hand, although predicting gender differences in partner selection and in openness to engage in sexual intercourse in short-term contacts, propose that gender differences, as well as cultural differences, may be less powerful in shaping sexual attitudes than individual differences (Hatfield & Rapson, 1993), including differences in sociosexual orientation (Simpson & Gangestad, 1991). Building on the theoretical work of Sternberg (1986) and Carver and Scheier (1990), Baumeister and Bratslavsky (1999) suggested that intimacy as such is not sufficient for inducing passion and sexual desire; instead, only abrupt rises in intimacy, such as when partners make up after a conflict, would allow sexual desire to arise. Thus, passionate love cannot persist during stable levels of emotional intimacy, however high they may be. Although the authors clearly distinguish passionate love from sexual desire, they further consider sexual desire and sexual behavior to both serve as “crude measures of passionate love, particularly when the data pertain to ongoing romantic relationships” (Baumeister & Bratslavsky, 1999, p. 52). They further hypothesized that a certain increment in intimacy causes a greater increment in sexual desire in men than in women. In women, the emergence of sexual desire would thus, as a logical consequence, depend on larger increments in intimacy than in men. Support for this proposition that the emergence of sexual desire requires a clear rise in intimacy was found in a longitudinal study (Rubin & Campbell, 2012), in which both partners of 67 heterosexual couples in long-term relationships completed a daily diary for 21 consecutive days. Couples were more likely to report having sex on a particular day if they experienced an increase in intimacy from the previous day. More intense passionate experiences during sex (e.g., having fun during sex) and feeling passionately attracted to one’s partner during sex were similarly reported following the increases in intimacy. However, the gender difference proposed by Baumeister and Bratslavsky (1999) regarding the connection between intimacy and passionate love did not receive support (Rubin & Campbell, 2012).

Relationship duration was found to be an important predictor of sexual partner interaction (Call, Sprecher, & Schwartz, 1995; Klusmann, 2002; McCabe & Goldhammer, 2012). In a national representative U.S. sample of married couples, the incidence and frequency of partnered sexual activity was found to decline over the life course (Call et al.,
Among the factors contributing to this decline were biological aging, diminished health, and habituation to sex. These factors can all be assumed to correlate substantially with longer relationship duration. Women in relationships of longer duration reported lower sexual desire (McCabe & Goldhammer, 2012). The negative association of relationship length and frequency of sexual contact were also found in young adults (Klussmann, 2002). In a sample of German heterosexual students aged 19–32 years living in a romantic partnership, sexual activity and sexual satisfaction were found to decline in both women and men in longer relationships. However, sexual desire was only found to diminish in women, while the desire for tenderness decreased in men whereas it became stronger in women.

The present study

The current study adopted a longitudinal approach for data collection and aimed to replicate and extend previous cross-sectional and longitudinal research (Dewitte et al., 2015; Ein-Dor & Hirschberger, 2012; Rubin & Campbell, 2012) by enabling time course analyses with a higher temporal resolution of data collected at multiple assessment points ($N = 12$) per day. To enhance the ecological validity of the data and the ability to make inferences about temporal associations, experience sampling methodology (ESM; Mehl & Conner, 2012; Myin-Germeys et al., 2009) was used. The ESM involves high-frequent assessment of behavior and experience in the participant’s natural environment, using random time sampling. The use of ESM has been found to yield realistic representations with high ecological validity of human experiences and behavior in the daily environment as they occur under natural circumstances (Hektner, Schmidt, & Csikszentmihalyi, 2007; Mehl & Conner, 2012; Myin-Germeys et al., 2009). Another advantage of ESM is the brief time between an event, behavior, or experience and the participant’s report on it, which reduces memory bias compared with other self-report methods that require participants to retrospectively report on their experiences across longer spans of time (Bolger, Davis, & Rafaeli, 2003). Our assumption that sexual desire and intimacy fluctuate considerably during the day and depend on contextual factors that can also be assessed using ESM is the rationale behind using as many as 10 measurements for these variables per day.

The current study, due to the use of multiple assessments per day, provided an assessment of circadian patterns of intimacy, sexual desire, and sexual activity, which will be described in some detail. We further predicted that (A) higher levels of intimacy are, both cross-sectionally and temporally, associated with higher levels of sexual desire and that (B) these associations of intimacy and sexual desire are moderated by gender. As a test of the proposition by Baumeister and Bratslavsky (1999), we expected a steeper slope in men of the regression coefficient of the association of increases in intimacy with sexual desire compared to women; (C) sexual desire will mediate the association of higher levels of intimacy with more frequent occurrence of partnered sexual interaction; and (D) the association of intimacy and sexual interaction will be moderated by gender, such that these associations will be stronger for women than for men. For men, we expect to find an attenuated association. Relationship duration will be included as a covariate in the analyses, considering that longer relationship duration is
associated with lower sexual desire (most prominently in women) and lower frequency of partnered sexual interaction.

Method

Sample

Participants were recruited from the circles of acquaintance of seven master’s students of the Open University in the Netherlands who participated in the data collection, securing wide geographical distribution in the Netherlands due to the distance education system of the Open University. Inclusion required that participants (a) were in a romantic heterosexual relationship of at least 6 months, (b) were at least 18 years of age, and (c) spoke Dutch and had completed at least 8 years of education (to ensure comprehension of the questionnaires). Due to the heterogeneity of the student population of the Open University, the sample was heterogeneous with regard to age, working status, education, ethnic background, and income level.

One hundred and thirty-four individuals ($N_{female} = 87$) participated. Male participants’ mean age was 46.4 years ($SD = 11.4$), and they had completed an average of 13.5 years ($SD = 3.1$) of education. Female participants’ mean age was 39.2 years ($SD = 10.7$), and they had completed 13.6 years ($SD = 2.4$) of education. Average relationship duration was 14.6 years ($SD = 11.0$) ranging from 1 to 47 years. Eighty-nine percent of female participants and 96% of male participants identified as Caucasian. Only one of the partners of a couple participated in the study.

ESM

Participants completed a brief paper-and-pencil questionnaire 10 times per day during 7 consecutive days. Participants wore a preprogrammed wristwatch that delivered the auditory signals (beeps) that served as prompts for the completion of the questionnaire. They were instructed to complete the questionnaire immediately after they received a beep, and their full comprehension of the instructions was checked. The beeps were delivered at quasi-random moments between 7:30 a.m. and 10:30 p.m. The intervals were chosen such that the exact beep times were unpredictable, even though they still approximated a fixed time series. Beeps were randomly distributed around fixed time points separated by 90 min each, with a maximum deviation of 20 min (de Vries, 1992). At the end of each questionnaire, participants reported the exact time at that moment. The time recorded by participants after they completed the questionnaire was compared to the actual time of the beep. Reports that were provided later than 15 min after the beep signal have been found less reliable and were therefore not used in analyses. At least one third of the possible reports are required to produce a valid data set (Delespaual, 1995). Participants with fewer than 24 valid reports of our main ESM variables (intimacy and sexual behavior) of the maximum of 70 possible reports were considered to be noncompliant and were excluded from the analyses. Additionally participants were instructed to fill in early morning and late evening diaries. These reports were not completed upon delivery of a signal, but contingent on, respectively,
the moment of waking up and immediately before going to sleep. The latter collected data about the period since the last beep signal of the evening.

**Procedure**

Potential participants received personal invitations including information about the requirements and methods of the study. When they agreed to participate, after reading and signing an informed consent form and completing an online questionnaire, an interview was scheduled, either face-to-face or by telephone, on the day immediately before the start of their participation. Participants received extensive explanation of the study procedure and were stimulated to pose any remaining questions. During this briefing session, participants also practiced completing the ESM questionnaire. Eligible participants received the wristwatch and seven diary booklets for the ESM assessments. After completing the last questionnaire, they were debriefed and asked for an evaluation of their participation. Anonymity was secured by marking each respondent’s data only with a research code and having them send their data by postal mail using prestamped envelopes to a fellow researcher, with whom the respondent was not acquainted, to code the diary data and enter these into the database. Participants were volunteers and did not receive any monetary compensation. Ethical approval of the institutional review board of the Open University was obtained.

**Intimacy**

Intimacy was measured at the beep level with 5 items using 7-point Likert-type scales (1 = *not at all*, 7 = *very strongly*). Item wordings were based on Sternberg’s description of state intimacy: “Towards my partner I now feel... ‘Intimacy,’ ‘Connectedness,’ ‘Love,’ ‘Tenderness,’ and ‘Warmth.’” Intimacy was defined as the mean score of the 5 items denoting feelings of intimacy, connectedness, love, tenderness, and warmth toward the partner. The items were answered using 7-point rating scales with category labels: 1 = *not*, 4 = *moderately*, and 7 = *very*. The reliability, McDonald’s (1999) $\omega$, of the intimacy factor at the person (i.e., aggregated over all assessments within a person) and at the beep level was determined with a multilevel confirmatory factor analysis using Mplus (Version 7.3, see Appendix 1 for statistical details). The intraclass correlations for the 5 items were high, ranging between .59 and .65. A one-factor model fitted the data well: comparative fit index (CFI) = .92, root mean square error of approximation (RMSEA) = .05, standardized root mean square residual (SRMR) = .038 (within) and .045 (between). At the person level, the estimated reliability was .91. At the beep level, the estimated reliability was .90.

**Sexual desire**

Sexual desire was measured at the beep level as the mean score of 3 items, using 7-point Likert-type scales (1 = *not at all*, 7 = *very strongly*). Item wordings were as follows: At this moment... “I feel sexual desire,” “I feel sexually excited,” and “I am open to sexual initiative.” The selected wordings reflect the current consensus in the field of sex
research with regard to sexual desire as comprised of both proactive and receptive elements and of sexual arousal, particularly in women (Basson, 2002). The 3 items intercorrelated highly (.76, .81, and .85). The reliability, McDonald’s (1999) \( \omega \), of the sexual desire factor at the person and at the beep level was determined with a multilevel confirmatory factor analysis using Mplus (Version 7.3). The intraclass correlations of the 3 items ranged between .41 and .43. A one-factor model fitted the data very well: CFI = .99, RMSEA = .02, SRMR = .00 (within) and .013 (between). At the person level, the estimated reliability was .86. At the beep level, the estimated reliability was .72.

**Sexual activity**

Sexual activity was measured at every beep and, additionally, immediately before going to sleep and upon awakening in the morning. Item wording was as follows: “Since the previous beep, I was sexually active…” Response options were as follows: “No,” “Yes, with partner,” or “Yes, I masturbated.” Data on masturbation are not further reported here.

**Covariates**

The presence of the partner (allowing partnered sexual activity to occur), day of the week, and interbeep interval length were assessed using the pertinent items in the ESM diary. Relationship duration was assessed.

**Data analysis**

Circadian patterns of intimacy, sexual desire, and sexual activity were analyzed using descriptive statistics, and curves were fitted for visual inspection.

Hypotheses A and B were tested at the beep level, which represents the lowest and most information-rich level. Hypothesis A, predicting sexual desire at a particular assessment \( t \) by intimacy at the previous assessment \( t−1 \), was tested in a multilevel analysis in R (R Core Team, 2016) using the package nlme (Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2016). We added the interaction term between gender and intimacy to test whether gender moderated the effect of intimacy on sexual desire. The same model was also tested for different time lags of intimacy and thus for intimacy measured at \( t−2 \) and at \( t−3 \). Next, we tested the hypothesis of Baumeister and Bratslavsky (1999) that the increase in intimacy within a period of time (e.g., between beep \( t−1 \) and \( t \)) leads to higher levels of sexual desire at \( t \). In all of the above analyses, relationship duration and the presence of the partner were included as covariates in the model. We assumed random intercepts across participants in all models and included an autocorrelation parameter at the assessment level.

Note that building a statistical model with sexual activity as dependent variable at the beep level is not possible because partnered sexual activity was only reported in an extremely small proportion of the cases.

To test Hypotheses C and D, the data were first aggregated across the assessments resulting in a data set using day level as the lowest level. The variable sexual activity was then recoded to indicate whether there had been partnered sexual activity that day (1) or
In this aggregated data set, intimacy and sexual desire indicate the average level of intimacy and sexual desire at the day level, respectively. The hypotheses were tested in a comprehensive mediation analysis at the day level (Bauer, Preacher, & Gil, 2006; Hayes, 2013; Kenny, Korchmaros, & Bolger, 2003; Preacher, Zyphur, & Zhang, 2010), using Mplus (Muthén & Muthén, 1998–2012).

Finally, we analyzed the same mediation model at the participant level by aggregating the data across days. In this aggregated data set at the participant level, intimacy and sexual desire indicate the average level of, respectively, intimacy and sexual desire of a respondent during the study. The variable sexual activity here indicates the total number of partnered sexual activities during the study. The hurdle model (Atkins, Baldwin, Zheng, Gallop, & Neighbors, 2013; Zeileis, Kleiber, & Jackman, 2008) was used to analyze the association at this level between partnered sexual activity and the predictors’ sexual desire and intimacy. Hurdle models are classes of models for count data that help handle excess zeros and overdispersion. In the case of sexual activity, the data contained many zeros, even after aggregating over assessments and days. The model consists of two parts: a binary logit model estimating whether sexual activity was reported (1) or not (0) and a truncated negative binomial (count) model that predicts the number of sexual activities. The details of the statistical models are described in the Appendix 2.

Results

Descriptive statistics

Full compliance would have resulted in 70 (7 days × 10 assessments per day) valid data records per participant. All participants completed more than the minimum number of 24 questionnaires. Three participants fully completed all questionnaires, one completed 26 questionnaires, and all others were somewhere between these values. The median value was 56 questionnaires (80%) completed within the 15-min time window after receiving the beep. No missing pattern was found for time of assessment. The number of missing observations increased somewhat as the study progressed over the consecutive days. The theoretical maximum number of records for a day is 1,340 (134 × 10), and in this study, the number ranged from 950 (last day) to 1,102 (first day). A slight dip is seen on the third day, which is a characteristic phenomenon for ESM data that has already been described (Delespaul, 1995). Descriptive data and correlations among the variables of interest are shown in Table 1.

Most participants reported experiencing feelings of intimacy toward their partner with a median score of 5.0 (Scales 1–7). The 25% and 75% percentile scores were, respectively, 3.9 and 5.7, indicating that 25% of the participants rated their relation as highly intimate on average (≥5.7). When intimacy is plotted as a function of the time of assessments across the day, averaged over participants and days, despite the narrow range of the intimacy scores, a clear pattern arises, which can almost perfectly be described by a quadratic function, see Figure 1.

After the start of the day, the daily intimacy curve gradually decreased, but from the seventh assessment onward (about 5–6 p.m.), the intimacy scores rose sharply; late in the
evening, intimacy was at its maximum. Men’s \( M = 4.80, SD = 1.5 \) and women’s reports of intimacy \( M = 4.72, SD = 1.6 \) did not differ meaningfully, \( F(1, 7,178) = 8.51; p = .004, \eta^2 = .00, 95\% \) confidence interval (CI) = [0.00, 0.00]. The presence of the partner

Table 1. Intimacy and sexual desire in individuals in romantic relationships: Descriptive statistics and correlations at the beep, day, and subject level.

|                    | Descriptive statistics | Correlations        |
|--------------------|------------------------|---------------------|
|                    | N | Mean | 95% CI | SD   | Sexual desire | Intimacy |
| Beep level         |   |      |        |      |              |         |
| Sexual desire      | 7,152 | 1.89 | [1.86, 1.92] | 1.37 |              |         |
| Intimacy           | 7,180 | 4.76 | [4.73, 4.80] | 1.56 | .26 [.24, .28]|         |
| Relationship duration |     |      |        |      | -.19 [-.21, -.16] | -.01 [-.04, .01] |
| Day level          |   |      |        |      |              |         |
| Sexual desire      | 938 | 1.93 | [1.85, 2.00] | 1.10 |              |         |
| Intimacy           | 938 | 4.80 | [4.71, 4.89] | 1.37 | .26 [.20, .32]|         |
| Relationship duration |     |      |        |      | -.25 [-.31, -.19] | -.02 [-.09, .04] |
| Subject level      |   |      |        |      |              |         |
| Sexual desire      | 134 | 1.89 | [1.74, 2.04] | 0.85 |              |         |
| Intimacy           | 134 | 4.79 | [4.57, 5.01] | 1.28 | .26 [.09, .41]|         |
| Relationship duration |     |      |        |      | -.31 [-.46, -.14] | -.02 [-.19, .16] |

Figure 1. Intimacy as a function of the time of assessments across the day, averaged over participants and days. The empty triangles and solid line depict female scores. The inverted black triangles and dashed line depict male scores.
in 21.6% of the observations was an important factor, $F(1, 7178) = 8.51; p < .001, \eta^2 = .07, 95\% \text{ CI } [.06, .08]$, for the level of reported intimacy. The distribution of sexual desire in the full sample, averaged over assessments and days, reveals an average score of 1.9, $SD = .93$ (Scales 1–7). Four participants had an average score above 4. Average level of sexual desire was slightly higher on nonwork days ($M = 2.0, SD = 1.5$) compared to work days ($M = 1.7, SD = 1.2$), $F(1, 5855) = 99.4, p < .001, \eta^2 = .02, 95\% \text{ CI } [.01, .02]$. Desire was also higher in men ($M = 2.3, SD = 1.5$) compared to women ($M = 1.7, SD = 1.2$), $F(1, 7150) = 342.2, p < .001, \eta^2 = .05, 95\% \text{ CI } [.04, .05]$. The difference between men and women was significantly smaller on work days compared to nonwork days, $F(1, 5853) = 16.2, p < .001, \eta^2 = .02$.

The distribution of sexual desire scores over assessments per day strongly resembled that of intimacy, see Figure 2. There was a subtle difference though, whereas intimacy started increasing at Assessment 7, it appeared that sexual desire only started rising at Assessment 8 (between 6.30 and 7.30 p.m.). The patterns were not significantly different between the genders, $F(9, 7132) = .73, p = .68, \eta^2 = .02$.

A quadratic term significantly predicted both the intimacy scores ($B = .012, SE = .001, p < .001$) and the sexual desire scores ($B = .014, SE = .001, p < .001$). We used a technique reported by Nelson and Simonsohn (2014) in order to test the point at which desire and intimacy increased. The beeps were centered at the value 4, which seemed the minimum value after visual inspection of the figure, in order to test the point

![Figure 2. Sexual desire as a function of the time of assessments, averaged over participants and days. The empty triangles and solid line depict female scores. The inverted black triangles and dashed line depict male scores. The stars and dotted line depict the sexual desire scores averaged across genders.](image-url)
at which desire and intimacy increased. Two separate linear regressions were conducted:

one for the association between beeps and desire and intimacy, respectively, for the first four beeps and one for the second part (Beeps 5–10). We found that before Beep 5, early in the day, there was a nonsignificant negative effect ($B = -.023, SE = .011, p = .164$) for intimacy and a significant negative effect ($B = -.039, SE = .007, p = .034$) for sexual desire. From Beep 5 onward, both desire and intimacy significantly increased ($B = .101, SE = .007, p < .001$ for intimacy and $B = .096, SE = .017, p = .005$ for sexual desire). This confirms the effect suggested by the figures that after Beep 4, the levels of sexual desire and intimacy are rising.

In 4.3% of the assessments, participants reported that sexual activity had taken place (1.8% in the form of masturbation and 2.5% as partnered sexual activity). No partnered sexual activity was reported by 32.1% of the participants; 19.4% reported one, 18.7% reported two, and 13.4% reported three partnered sexual activities, while still smaller percentages of participants reported higher numbers of partnered sexual activities during participation in the study.

Both men and women most often reported sexual activity at the last assessment (late evening) and at the first assessment (night and early morning). The effect of assessment day (1 through 7) on sexual activity was not significant, $F(1, 1,097) = .84, p = .539$.

**Testing the hypothesized temporal associations between intimacy and sexual desire at the beep level**

To investigate the temporal relation between intimacy and sexual desire, we tested several multilevel models. In the first model, intimacy at $t-1$ was taken as predictor for sexual desire at $t$ and gender as a moderator of this relationship. Results of this analysis are shown in Table 2. First the fixed effects are shown and next the random effects. A one-point increase in intimacy at time point $t-1$ was associated with higher sexual desire at time point $t$ with about .09 (all measured in standard deviations). The overall level (intercept) of sexual desire differed between men and women. For men, the level of sexual desire was .71, which was higher than for women. The presence of the partner had a positive effect on sexual desire, whereas relationship duration had a negative effect.

The analyses of the models with intimacy at $t-2$ and $t-3$ as predictors showed that with increasing time lags, the effect of intimacy decreased. The effects of the other variables in the model remained essentially the same. Figure 3 shows the difference in the intimacy effect on sexual desire as a function of the time lags, starting with time lag 0 (cross-sectional analysis).

Next, we tested the model proposed by Baumeister and Bratslavsky (1999). Compared with the previous model, the $t-1$ score for intimacy as predictor was replaced with the change score for intimacy between $t-1$ and $t$. Results are shown in Table 3. These results are very similar to the ones from the previous analyses. A one-point increase in intimacy between time point $t-1$ and time point $t$ was associated with an increase in sexual desire at time point $t$ with about .08 (measured in standard deviations). Gender did not moderate the effect of change in intimacy on sexual desire and thus failed to support Baumeister and Bratslavsky’s prediction.
Testing the hypothesized mediation effect of sexual desire on the association between intimacy and sexual activity at day level

To test the mediating role of sexual desire in the relation between intimacy and sexual activity at the day level, we defined a multilevel mediation model in Mplus (Version 7.3), using the procedure described by Preacher, Zyphur, and Zhang (2010). Results of this analysis are shown in Table 4. Daily intimacy significantly predicted sexual desire ($B = .239, SE = .065, p < .01$), and sexual desire significantly predicted sexual activity ($B = .610, SE = .155, p < .01$). The direct path between intimacy and sexual activity was weak and not significant ($B = .182, SE = .146, p = .213$), but the indirect effect through sexual desire was significant ($B = .224, SE = .106, p = .034$).

Testing the hypothesized cross-sectional associations between intimacy, sexual desire, and partnered sexual activity

To examine the association between sexual desire, intimacy, and partnered sexual activity, with sexual activity assumed to be depending on the other two, we used the hurdle model. The results are shown in Table 5. Sexual desire was the only significant predictor for sexual activity in both models, predicting both the number of sexual activities ($B = .39, SE = .09, p < .001$) and the log odds of sexual activity versus no sexual activity ($B = .51, SE = .26, p = .047$). The interaction between intimacy and gender in both models was weak and not significant.
Discussion

In this study, the link between intimacy, sexual desire, and partnered sexual activity was investigated in a sample of heterosexual women and men in romantic relationships. On a descriptive level, a U-shaped daily “intimacy curve” was found with higher levels of intimacy during late afternoon, evening, and early morning. Sexual desire followed a similar circadian pattern across the day. Both curves were highly similar for men and women. The direct association of perceived intimacy with the partner and sexual interaction with the partner proved not significant but appeared to be explained by the effect of intimacy on sexual desire. Although the adequacy of performing mediation analysis in the absence of a direct effect between independent and dependent variables could be questioned and might point to the existence of common confounding sources of sexual desire and intimacy that were not accounted for in the model, mediation can occur even without a significant total effect (see Hayes, 2013, for a discussion and examples).

These findings provide partial support for models of sexual functioning incorporating social–emotional factors including intimacy and relational satisfaction (Basson, 2000; Birbaum et al., 2007; Bodenmann et al., 2006; Ein-Dor & Hirschberger, 2012; Hinchliff & Gott, 2004; Klusmann, 2002; Stephenson & Meston, 2010). Although we found higher levels of intimacy and sexual desire in men than in women, the gender differences regarding the intimacy–sex link that feature prominently in some of the theoretical models
of partnered sexuality (Basson, 2000; Klusmann, 2002; Schnarch, 1997) were not found in the present data. Thus, intimacy appears to act as a precursor of sexual desire that, in turn, increases the odds for partnered sexual activity to occur for both women and men.

The results of our study failed to support Baumeister and Bratlavsky’s (1999) prediction that men would show a stronger link between daily rises in intimacy and daily sexual desire than would women. The absence of a gender effect on the intimacy–sexual desire link in our study is in line with findings from previous daily diary research among nonclinical couples (Dewitte et al., 2015; Rubin & Campbell, 2012). Future research into this effect in clinical populations is needed to ascertain whether the gender-specific approach that is advocated in some couples-based therapeutic programs for low sexual desire (e.g., Schnarch, 1997) remains useful.

### Table 3.
Prediction of sexual desire by change in intimacy from a previous assessment point: fixed and random effects (Baumeister and Bratslavsky model).

| Parameter                        | Estimate | SE  | t    | Significance | 95% confidence interval |
|----------------------------------|----------|-----|------|--------------|-------------------------|
| Interception                     | −.263    | .067| −3.92| .000         | −.395 − .131            |
| Intimacy (change score)          | .082     | .012| 6.76 | .000         | .058 .105               |
| Gender (male)                    | .505     | .114| 4.43 | .000         | .279 .731               |
| Presence partner (yes)           | .274     | .023| 11.90| .000         | .229 .319               |
| Relationship duration            | −.246    | .054| −4.53| .000         | −.353 − .139            |
| Gender × Intimacy                | .023     | .019| 1.19 | .235         | −.015 .060              |

### Table 4.
The association between sexual activity and intimacy, mediated by sexual desire.

| Effect                           | Estimate | SE  | Estimate/SE | Significance |
|----------------------------------|----------|-----|-------------|--------------|
| Intimacy–sexual desire           | .239     | .065| 3.700       | .000         |
| Sexual desire–sexual activity    | .610     | .155| 3.941       | .000         |
| Intimacy–sexual activity         |          |     |             |              |
| Direct                           | .182     | .146| 1.245       | .213         |
| Indirect                         | .224     | .106| 2.120       | .034         |

Note. Dependent variable: Sexual activity (yes vs. no) at day level (N = 938).
A limitation of the present study is the possibility that participants completed questions after more than 15 min following the beep, even when they reported to have completed their diary within the required time limit, which would reduce the reliability of the data. Although some ESM researchers have questioned participant compliance in paper-and-pencil ESM studies and prefer the use of electronic devices (Bolger et al., 2003; Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002), later empirical studies have demonstrated satisfactory compliance rates (questionnaire completion after at least 80% of the beeps) with both paper-and-pencil protocols and protocols involving data collection using electronic devices. Both data acquisition methods produced data with comparable psychometric characteristics and research findings (Green, Rafaeli, Bolger, Shrout, & Reis, 2006; Jacobs et al., 2005). The present study protocol was comparable with the protocols in the latter studies. Another limitation concerns the unknown magnitude of measurement reactivity of the ESM. The evidence for the existence of substantial measurement reactivity or fatigue during assessment of subjective experience in ecological momentary assessment using high-frequent diary entries is mixed. Although pattern changes of diary entries across multiple days have been found (e.g., Reynolds, Robles, & Repetti, 2016), suggesting both measurement reactivity and fatigue-related declines in response accuracy, the observed effects were small. In a study among university students, Gillmore and colleagues (2001) collected daily diary responses to sex-related and other health-related questions over a period of 2 months. A significant trend was found toward decreased reporting of drinking, smoking, and sexual intercourse. In the present study, no effects across the measurement week were found with regard to reporting sexual activity, and neither were any changes over time found in the association between perceived intimacy and sexual desire. Another limitation concerns the

### Table 5. The association between sexual activity, intimacy, and sexual desire at subject level using the hurdle model.

| Model                        | B     | SE  | z     | Lower bound CI | Upper bound CI | Significance |
|------------------------------|-------|-----|-------|----------------|----------------|--------------|
| **Count model coefficients (negative binomial with logit link)** |       |     |       |                |                |              |
| Intercept                    | .766  | .122| 6.30  | .000           | .528           | 1.010        |
| Sexual desire                | .393  | .095| 4.14  | .000           | .223           | 0.648        |
| Intimacy                     | .032  | .118| 0.27  | .787           | −.187          | 0.281        |
| Gender (male)                | −.051 | .202| −0.25 | .800           | −.448          | 0.352        |
| Relationship duration        | −.084 | .110| −0.77 | .444           | −.293          | 0.136        |
| Gender × Intimacy            | −.334 | .199| −1.68 | .092           | −.754          | 0.033        |
| **Zero hurdle model coefficients (binomial with logit link)** |       |     |       |                |                |              |
| Intercept                    | 1.072 | .268| 3.99  | .000           | .547           | 1.603        |
| Sexual desire                | 0.516 | .260| 1.99  | .047           | 0.010          | 1.047        |
| Intimacy                     | 0.277 | .229| 1.21  | .226           | −.168          | 0.727        |
| Gender (male)                | −.735 | .452| −1.63 | .104           | −1.608         | 0.164        |
| Relationship duration        | 0.116 | .212| 0.55  | .586           | −.301          | 0.516        |
| Gender × Intimacy            | −.086 | .416| −0.21 | .837           | −.906          | 0.725        |

Note. Dependent variable: Partnered sexual activity at subject level. Intimacy, sexual desire, and relationship duration are standardized (N = 134). CI = confidence interval.
impact of less than perfect compliance of participants to complete the questionnaires after they received a beep signal. This might have consequences for the observed frequency of noncontinuous data, including the occurrence of sexual activity. First, the percentage of missing assessments is well below the limit of 70\% recommended by Delespaul (1995). If the data of the missed assessments would have the same distribution as the completed assessments, this could have major consequences for the frequency of occurrence of partnered sexual activities, which might almost be double compared to the observed count. However, although it is impossible to empirically compare missing and nonmissing data, we think it is plausible to speculate that at least a substantial part of the missing assessments was due to participants being occupied at that moment with work duties or other activities that would also prevent them from being sexually active. The coherent circadian patterns that were found for the key variables in this study may indicate that we were able to accurately capture relevant dynamics of intimacy, sexual desire, and partnered sexual activity in daily life.

Other, sample-related, limitations of the present study concern the unknown impact of self-selection bias and the almost exclusively Caucasian sample. Our sample also included only one member of a romantic relationship. However, the behavior and communicated experiences of the partner probably have important additional explanatory power for the individual’s experiences of intimacy and sexual desire. Another reason why dyadic analyses are an important next step in future research is that partners’ work schedules often do not align. The effects of such nonsynchronous work schedules on intimacy, sexual desire, and partnered sexual activity can better be investigated when both partners’ data are included. We therefore recommend that the current investigation of individual men and women living in romantic relationships is followed up in future studies in which data are collected from both members of romantic couples.

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ORCID iD
Jacques van Lankveld http://orcid.org/0000-0003-0956-4067

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Notes
1. When testing our hypotheses, the same pattern of results was found in analyses in which the presence of the partner and relationship duration were and were not included as covariates.
2. The statistics of the regression analyses using data at $t - 2$ and $t - 3$ are provided as Supplementary Material to this publication.
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Appendix 1

The reliability of the intimacy factor at a particular level can be estimated with the equation:

$$\omega = \frac{(\Sigma \lambda_i)^2}{(\Sigma \lambda_i)^2 + (\Sigma \varepsilon_i)^2};$$

(1A)

where $(\Sigma \lambda_i)^2$ denotes the squared sum of the five loadings for the intimacy factor and $(\Sigma \varepsilon_i)$ denotes the sum of the error variances of the 5 items (Werts, Linn, & Jöreskog, 1974).

Appendix 2

We formulated the following statistical model to test the hypothesis from Baumeister and Bratslavsky (1999) that the increase in intimacy within a period of time leads to higher levels of sexual desire, following standard multilevel notation for the parameters:

$$SD_{jkt} = b_{0j} + b_{1j}I_{jkt-1} + r_{jkt}$$

(2A)

Here, index $j (j = 1–134)$ denotes the participants, index $k (k = 1–7)$ denotes the days, and $t$ denotes the time points (assessment; $t = 1–10$). The slope ($b_{1j}$) captures Baumeister and Bratslavsky’s (1999) gender effect. The intercept ($b_{0j}$) captures all determinants of sexual desire that cannot be explained by the increase in intimacy. The effect of intimacy at $t - 1$ upon sexual desire is assumed to vary across participants, in particular as a function of gender ($G$). Likewise, the intercept is assumed to vary across participants, also as a function of gender. The subject-level variable gender is thus added as a subject-level predictor of both the intercept and the slope of perceived intimacy, thus

$$b_{0j} = \gamma_{00} + \gamma_{01}G + u_{0j},$$

(2B)

$$b_{1j} = \gamma_{10} + \gamma_{11}G + u_{1j}.$$  

(2C)

The parameter $\gamma_{11}$ now denotes the interaction effect of gender and change in intimacy. Furthermore, we model the residuals at the beep level to be autocorrelated with lag 1 (AR1).