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# **Up-regulation of Sexual Desire in Long-term Relationships: Self-report and Electrophysiological Data**

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B.A. Interdisciplinary Arts and Sciences in Psychology, University of Washington-  
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in partial fulfillment of the requirements for the degree  
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### Abstract

Diminished sexual desire is a common in long-term relationships yet little research has examined strategies to promote sexual desire within healthy intact couples. This study focused on three regulation strategies: 1) positive reappraisal of the partner, 2) reappraisal of sexual desire decline, and 3) sexual imagery. These regulation strategies were used to test for an increase in sexual desire, infatuation, attachment, and relationship satisfaction for the partner. We additionally examined whether these strategies increased motivated attention to the partner as indicated by the late positive potential (LPP), an event-related potential (ERP) component. Participants ( $N=25$ , age=18-32 yrs, 6 men) in long-term relationships of at least two years completed the three regulation conditions and a no regulation condition while their electroencephalogram (EEG) was recorded. At the end of each condition block they completed four ratings: sexual desire, attachment, infatuation, and relationship satisfaction. Participants felt more sexual desire for and felt more infatuated with their partner after sexual imagery than after no regulation. There were no additional changes in sexual desire, infatuation, attachment, or relationship satisfaction resulting from the strategies tested. Further, there were no significant differences in the LPP amplitude between conditions. Given that sexual desire typically declines over the course of a relationship, the use of sexual imagery could help those in long-term relationships who wish to maintain or increase sexual desire for their partner and could also help increase infatuation for their partner.

### Up-regulation of Sexual Desire in Long-term Relationships: Self-report and Physiological Data

It is not unusual for one, or both, partners in a long-term relationship to experience scarce passion or waning libido after some time. Diminished sexual desire is a challenge couples often face in long-term relationships (Clement, 2002). While sexual desire problems do not necessarily indicate deep-rooted relationship problems (Mintz, Sanchez, & Heatherly, 2017), conflicts about sex are concerns that bring couples to therapy (McCarthy & Wald, 2015), or otherwise lead them to seek alternative self-help remedies (Herbenick, Mullinax, & Mark, 2014).

Sexual desire is defined as having an interest in sexual activity that leads the individual to seek out sexual activity and/or be pleasurable receptive to the partner's initiation (Basson, 2008). With a number of individual-, partner-, and relationship-related factors identified as influences on sexual desire (Velten & Margraf, 2017), various approaches have been explored to treat sexual desire problems in relationships. Both pharmacological and psychological therapies have been used to treat desire-related sexual dysfunction and disorders individually. For instance, testosterone patches have been used to treat hypoactive sexual desire disorder (HSDD) in menopausal women (Buster et al., 2005) and testosterone replacement therapy has been used to increase sexual desire in men with conditions such as aging, coronary heart disease, and diabetes (Hackett et al., 2017; Mueleman & Van Lankveld, 2004; O'Carroll & Bancroft, 1984). Although there has been interest in pharmacological options for low sexual desire, psychological treatments, such as cognitive-behavioral therapies (CBT), have been a mainstay in treating sexual desire problems, particularly in women (Brotto, 2017; Hucker & McCabe,

2014; Silverstein, Brown, Roth, & Britton, 2011; Trudel et al., 2001). Couples' sex therapy offers various strategies that focus on the relationship rather than individual symptomology, including better communication and problem-solving techniques (Schnarch, 2010; Young, Negash, & Long, 2009), psychosexual exercises (McCarthy & Wald, 2015), as well as integrated models (Schwartz & Southern, 2018).

What the aforementioned therapies have in common is that they target sexual dysfunction in both clinical populations, and in couples who are experiencing relationship dysfunction and distress related to low sexual desire. However, there is a lack of research, outside of clinical intervention, that examine strategies to promote sexual desire in the context of healthy intact couples, particularly in ongoing relationships. Taking into account the subjective nature of desire, and the lack of "one size fits all" approach to address desire concerns, it is important to consider other ways to increase sexual desire in long-term relationships. One way may be to employ intrapersonal strategies to increase sexual desire specifically for the partner.

Cognitive reappraisal is a commonly used regulation strategy that involves changing the way one thinks about stimuli to alter how they make one feel (Cutuli, 2014; J. J. Gross, 2002; J. J. Gross & Thompson, 2007). For instance, after moving to a new city, you could reframe the event as an opportunity for you to meet new people and expand your network to feel more excited about moving to a new place. In addition to cognitive reappraisal being effective for regulating emotions (Webb, Miles, & Sheeran, 2012), it has implications for better interpersonal functioning and sense of well-being (J.J. Gross & John, 2003). In a previous study (Langeslag & Van Strien, 2016), participants reported using positive reappraisal to maintain long-term relationships (i.e.

focusing on positive aspects of the beloved/relationships and thinking about positive future scenarios) and felt more attached after using positive reappraisal. So, it seems likely that positive reappraisal of the partner would also increase sexual desire for the partner, but that has not yet been tested.

Another form of cognitive reappraisal involves reinterpreting the emotion itself (Webb et al., 2012). For example, after moving alone to a new city, you could remind yourself that it is normal to feel anxious. Reappraisal of emotion is a part of Acceptance and Commitment Therapy (ACT) that works by counteracting maladaptive response-focused emotion regulation strategies such as suppression (i.e. hiding the way they are feeling; (J.J. Gross & John, 2003; Hofmann & Asmundson, 2008). Meta-analyses showed that reappraisal of emotions is effective for regulating emotions (Hofmann, Sawyer, Witt, & Oh, 2010; Webb et al., 2012) and that mindfulness is effective in decreasing negative emotional experience and increasing positive affect (Hofmann et al., 2010). Another study found that acceptance predicted lower levels of negative affect and depressive symptoms associated with negative emotional situations such as life stress (Shallcross, Troy, Boland, & Mauss, 2010), suggesting that reappraisal of emotions was the underlying mechanism of adaptive coping strategies such as acceptance. In a similar manner, seasoned therapists have found that reducing/relieving sexual anxiety can release inhibition and increase sexual desire (Mintz et al., 2017). Thus, it seems feasible that telling yourself it is normal to experience low sex drive in a long-term relationship and accepting it without judgement could lead to increased sexual desire.

Concentration refers to emotion regulation strategies that direct attention to emotional components of a situation (J. J. Gross & Thompson, 2007). For instance, when

experiencing discontent after living in a big city for a while, you could imagine yourself reexperiencing previous events such as visiting a museum with friends, or envision yourself doing something new and fun in order to renew your excitement and interest in living there. Researchers have operationalized concentration in several distinct ways in which individuals are directed to attend to, focus on, make judgments about, or relive an emotional experience (Webb et al., 2012). In one study, participants were asked to focus on the feelings and bodily responses an event triggered and to let themselves feel the event as if they were there, “reliving it and reexperiencing it” (Ayduk, Mischel, & Downey, 2002). This self-immersed, directed attention toward feelings (manifested by mental stimuli) activates relatively concrete representations of the experienced emotions (Kross, Ayduk, & Mischel, 2005). Likewise, because individuals suffering from low sexual desire frequently report ceasing to think about sex, some therapists hold that increasing sexual thoughts and fantasies can improve sexual functioning and have utilized sexual fantasizing as a method to treat couples with sexual dysfunction (Goldey & Van Anders, 2012; Hall, 2010; Menahem, n.d.). Sexual fantasizing is similar to concentration in that it draws focused attention to an emotional situation via mental imagery. For example, as part of an integrated treatment approach, some therapists have suggested clients set their cell phones alarms (at pre-determined times), stop what they are doing when the alarm goes off and take a “five-minute sex break” in their mind by thinking of some type of arousing sexual encounter (Mintz et al., 2017). One empirical research paper showed that fantasizing about the partner, versus fantasizing about someone else, was associated with heightened desire and increased engagement in relationship-promoting behaviors (Birnbaum, Kanat-Maymon, Mizrahi, Recanti, & Orr,

2018). However, individual studies within the paper included newer relationships (some as new as 1 month) and did not explicitly assess whether sexual fantasizing is effective in long-term relationships, in which the decline of sexual desire is often a problem. Still, individuals in long-term relationships who want to increase sexual desire for their partner may be able to do so by focusing on and thinking about sexual situations involving their partner.

The study of regulation has largely been informed by using event-related potentials (ERPs). The late positive potential (LPP), an ERP component, reflects multiple and overlapping positivities over the posterior scalp beginning in the time range of the classic P300 (i.e. around 300ms after stimulus onset). The LPP amplitude is typically enhanced for both negative and positive compared to neutral stimuli (Hajcak, Weinberg, MacNamara, & Foti, 2011). Additionally, how much the LPP increases in response to emotional stimuli depends on the subjective value, or motivational intensity, of the stimuli (Hajcak, MacNamara, & Olvet, 2010). The LPP is thought to reflect motivated attention for emotional information (Hajcak, Moser, & Simons, 2006) and previous studies have shown that the LPP is enhanced in response to beloved-related stimuli (Langeslag, Franken, & Van Strien, 2008; Langeslag, Jansma, Franken, & Van Strien, 2007). Importantly, the LPP amplitude is modulated by regulation instructions according to the regulatory goal: up-regulation typically enhances the LPP amplitude, whereas down-regulation typically reduces it (Hajcak et al., 2010). For example, in a previous study investigating whether down-regulation of love feelings may help people cope with a break-up, the LPP was smaller in response to viewing ex-partner pictures after down-regulation than after no regulation (Langeslag & Sanchez, 2017). In another previous

love regulation study, the LPP was larger in response to viewing partner pictures after up-regulation, and the more participants showed an enhanced LPP in response to up-regulation compared to passive viewing, the more their negative affect decreased as a result of the up-regulation (Langeslag & Van Strien, 2016). This indicates that the LPP can be used to demonstrate how regulation changes the amount of attention that is paid to the partner.

The purpose of the present study is to examine up-regulation strategies that may increase sexual desire in long-term relationships. This study focuses on positive reappraisal of partner, reappraisal of sexual desire decline, and sexual imagery. The first research question is: Are positive reappraisal of partner, reappraisal of sexual desire decline, and sexual imagery effective strategies for increasing sexual desire for a long-term partner? Based on previously mentioned research, it is hypothesized that all three regulation strategies will increase feelings of sexual desire for the partner. The second research question is: Are positive partner reappraisal, reappraisal of sexual desire decline, and sexual imagery effective strategies for increasing infatuation, attachment, and relationship satisfaction in long-term relationships? We expect to replicate previous findings in which positive reappraisal increases feelings of attachment, but not infatuation for the partner (Langeslag & Van Strien, 2016). Additionally, we anticipate that reappraisal of sexual desire decline and sexual imagery will increase attachment and infatuation. We further expect to find that all three regulation strategies will increase relationship satisfaction. This is particularly important given relationship satisfaction is positively associated with sexual satisfaction (Brezsnyak & Whisman, 2004; Byers, 2005; Sprecher, 2002), and changes in relationship satisfaction have been found to change

concurrently with sexual satisfaction (Byers, 2005; Sprecher, 2002). The final research question is: How do positive partner reappraisal, reappraisal of sexual desire decline, and sexual imagery influence motivated attention to the partner, as indicated by the LPP amplitude? Considering previous ERP research (Hajcak et al., 2011; Langeslag et al., 2008; Langeslag & Van Strien, 2016), we expect that all three strategies would increase the LPP amplitude in response to a picture of the long-term partner.

## Methods

### Participants

Twenty-five participants ( $M = 23.8$ ,  $SD = 3.2$ , range = 18–32 years, six men) who were in a long-term relationship were recruited from the University of Missouri-St. Louis and the greater St. Louis community (using advertisements on ResearchMatch, Craigslist, and Facebook). Several studies of long-term relationships relating to relationship and sexual satisfaction have been conducted (Blumstein & Schwartz, 1983; Byers, 2005; Fallis, Rehman, Woody, & Purdon, 2016; Lawrance & Byers, 1995), with a minimum amount of time for relationships to be considered “long-term” ranging from 12 to 24 months. Therefore, only participants who were in a relationship for two or more years were included in the study.

Additional inclusion criteria, assessed by self-report over email or phone, were: normal or corrected-to-normal vision, no neurological or psychiatric disorders, and no current use of medications known to affect the central nervous system. Twenty-four participants were right-handed, and one was left-handed as determined by a hand preference questionnaire (Bryden, 1982). The study was approved by the University of Missouri-St. Louis institutional review board. Participants provided written informed consent and were compensated with course credit or \$25.

### Stimuli

Participants provided 30 digital pictures of their partner. The only requirements were that the pictures had to contain the partner and had to be non-intimate/non-explicit (for ethical reasons). Therefore, the pictures could display parts of the partner (e.g., just the face) or the whole body of the partner, people other than the partner, and a variety of

facial expressions, objects, and scenery (cf. (Langeslag & Van Strien, 2016). It is important to note that the variety of information on the pictures does not confound the regulation effects, because each picture was presented in each regulation condition.

### **Procedure**

Participants first completed some general questions about their relationship (cf. (Langeslag & Van Strien, 2016) and sexual desire. Specifically, participants were asked about the duration of their relationship and about its status (married, cohabiting, non-cohabiting). They were also asked how satisfied they found their sex life with their partner to be (1 = not at all, 9 = extremely) and how their sexual desire for their partner has changed over the course of the relationship (1 = decreased a lot, 5 = stayed the same, 9 = increased a lot). Additionally, participants were asked to identify their gender and the gender of their partner to collect basic demographics.

Next, participants completed one subscale of the Sexual Desire Inventory-2 (SDI-2) (Spector, Carey, & Steinberg, 1996). The SDI-2 is a commonly used instrument to evaluate sexual desire, defined by Spector and colleagues (Spector et al., 1996) as an “interest in sexual activity, which can be measured by amount and strength of thought directed toward sexual stimuli”. The original SDI-2 conceived sexual desire as having two dimensions: dyadic sexual desire and solitary sexual desire (Spector et al., 1996). A subsequent model (Moyano, Vallejo-Medina, & Sierra, 2017), confirmed by exploratory and confirmatory factor analyses conducted on all 14 items, supports a three-factor structure of the SDI-2: 1) partner-focused dyadic sexual desire, 2) dyadic sexual desire for an attractive person, and 3) solitary sexual desire. Because we were interested in upregulating sexual desire explicitly for the partner, participants completed only the

partner-focused dyadic sexual desire subscale (items 1, 2, 3, 6, 7, 8, 9) of the SDI-2. Since we were interested in up-regulation of sexual desire for the current partner specifically, we changed the wording of items on the partner-focused subscale from “a partner” to “your partner”. Like the original SDI-2, these subscale items were used to assess the strength and frequency of sexual desire specific to a partner. It should be noted that within the partner-focused dyadic subscale, there are two distinct subscales, one measuring strength, and the other measuring frequency of sexual desire. The average score on the SDI-2 subscale for strength of sexual desire for partner can range from 0 to 8 (items 3, 6, 7, 8, 9), and the average score on the SDI-2 subscale for frequency of sexual desire for partner can range from 0 to 7 (items 1, 2).

Then, participants completed the new Love Control Questionnaire III (LCQ-III), which was modified from our previous Love Control Questionnaire II (LCQ-II; (Langeslag & Sanchez, 2017). The new LCQ-III assesses perceived control of sexual desire, infatuation, and attachment. Items were phrased to measure one’s own perceived ability, as well as the perceived ability of others, to up- and down-regulate sexual desire, infatuation, and attachment. Participants rated items on a 9-point scale (1 = totally disagree; 9 = totally agree), so the average score can range from 0 to 9. Participants also completed the Infatuation and Attachment Scales (IAS; (Langeslag, Muris, & Franken, 2013) to assess the current intensity of infatuation with and attachment to their partner. The average score on each of the IAS scales can range from 1 to 7. Finally, participants completed the Revised Dyadic Adjustment Scale (RDAS; (Busby, Christensen, Crane, & Larson, 1995) to measure relationship quality and satisfaction, with the possible average score ranging from 0 to 5.

After completing the questionnaires, participants completed a regulation task while their electroencephalogram (EEG) was recorded. There were four conditions: 1) positive reappraisal of partner, 2) reappraisal of sexual desire decline, 3) sexual imagery, and 4) no regulation. In addition to the four main blocks, one per condition, there was a practice block, which contained four practice trials, one for each condition. Block order was counterbalanced between participants to reduce order effects. Each of the four main blocks contained 30 trials, and all trials consisted of a regulation prompt (see below) for five seconds, a fixation cross jittered for 500-700 milliseconds, a picture of the partner for one second, and a blank screen for one second, see Fig. 1.

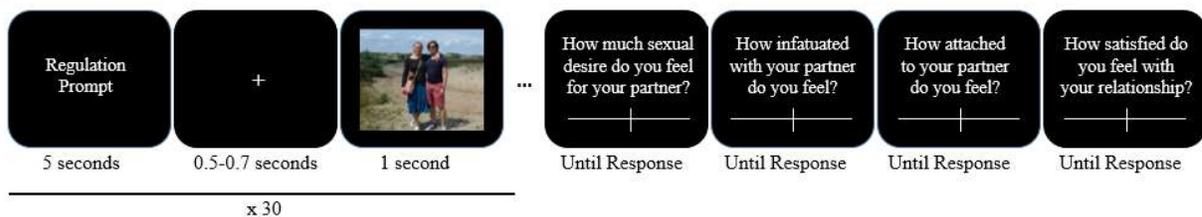
The regulation prompts in the positive reappraisal of partner condition were statements that made participants think about the positive aspects of their partner (e.g. “Think of a time your partner said something that made you laugh”). Participants were instructed to think about the particular instance for the duration the statement was presented on the screen. The regulation prompts in the reappraisal of sexual desire decline condition were statements that normalized and reinterpreted common misconceptions about the decline of sexual desire in long-term relationships (e.g. “It’s normal for sexual desire to diminish over time”). Participants were instructed to repeatedly read the statement and to try to believe it for the duration it was presented on the screen. The regulation prompts in the sexual imagery condition were statements that evoked sexual thoughts and fantasies specific to the partner (e.g., “Imagine something naughty your partner could say during sex”). Although it is common for couples in a long-term relationship to have engaged in some type sexual activity together (e.g., foreplay, intercourse), not all long-term couples have. Given this consideration, the

sexual imagery prompts were designed with the word “imagine”, so that even people who had not yet had sex with their partner could create mental images of these scenarios.

Participants were instructed to imagine the particular instance for the duration the statement was presented on the screen. In the no regulation condition, the prompt consisted of three asterisks and participants were not instructed to think about anything in particular.

There were 30 different prompts per condition, see Appendix, and each prompt was presented once. After the regulation prompt and the fixation cross, a picture of the partner was presented, and participants were instructed to passively view it. Participants were asked to limit movements and to try not to blink during presentation of the fixation cross and the picture.

At the end of each block, participants used sliders to complete four ratings: sexual desire (i.e., “How much sexual desire do you feel for your partner?”), infatuation (i.e. “How infatuated with your partner do you feel?”), attachment (i.e. “How attached to your partner do you feel?”), and relationship satisfaction (i.e. “How satisfied do you feel with your relationship?”). The sexual desire slider ranged from “no desire at all” on the left to “extreme desire” on the right. The infatuation, attachment, and relationship satisfaction sliders ranged from “not at all” on the left to “extremely” on the right. The use of a slider yielded continuous measures, which allowed for the detection of more subtle effects of regulation than a point-scale.



**Fig. 1** Task Overview. The slider for sexual desire ratings ranged from “no desire at all” on the left to “extreme desire” on the right. The infatuation, attachment, and relationship satisfaction sliders ranged from “not at all” on the left to “extremely” on the right.

### **Electroencephalogram (EEG) Recording and Signal Processing**

The EEG was recorded using a 32-channel amplifier and data acquisition software (ActiveTwo System, BioSemi). The 32 Ag-AgCl active electrodes were connected to the scalp through a head cap (BioSemi), according to the 10–20 International System (Fp1/2, AF3/4, Fz, F3/4, F7/8, FC1/2, FC5/6, Cz, C3/4, T7/8, CP1/2, CP5/6, Pz, P3/4, P7/8, PO3/4, Oz, O1/2). Vertical electrooculogram (VEOG) and horizontal electrooculogram (HEOG) were recorded by attaching additional electrodes (UltraFlat Active electrodes, BioSemi) above and below the left eye, and at the outer canthi of both eyes. Additionally, two electrodes were placed on the left and right mastoids (M1/2). An active electrode (CMS - common mode sense) and a passive electrode (DRL - driven right leg) were used to comprise a feedback loop for amplifier reference. Signals were digitized with a sampling rate of 512 Hz, a 24-bit A/D conversion, and a low pass filter of 134 Hz.

Data were analyzed with BrainVision Analyzer 2 (Brain Products, Gilching, Germany). A maximum of one bad electrode per participant was corrected using spherical spline topographic interpolation. Offline, an average mastoids reference was applied since that is the preferred reference when studying the emotional modulation of the LPP (Hajcak et al., 2011). The data was filtered using a 0.10-30 Hz band pass filter (phase shift-free Butterworth filters; 24 dB/octave slope) and a 60 Hz notch filter. Data were segmented in epochs from 200 ms before the onset of the partner picture until 1000 ms post-picture onset. Ocular artifact correction was applied semi-automatically

according to (Gratton, Coles, & Donchin, 1983). The mean 200 ms pre-stimulus period was used for baseline correction. Artifact rejection was performed at individual electrodes with a baseline-to-peak minimum and maximum criterion of  $-75$  to  $+75$   $\mu\text{V}$ . At least 12 trials are needed to obtain a reliable emotional modulation of the LPP (Moran, Jendrusina, & Moser, 2013). Every participant had at least 16 trials available in each regulation condition at each of the nine electrodes included in the analyses (see below), so no participants were excluded.

### **Statistical Analyses**

For the ratings, the slider responses were converted to a value ranging from 0 (i.e., far left) to 100 (i.e., far right). Ratings were analyzed using repeated measures analyses of variance (rmANOVAs) with the factor Condition (positive reappraisal of partner, reappraisal of sexual desire decline, sexual imagery, and no regulation). The LPP in response to the partner picture was quantified by a mean amplitude measure in a 400-1000 ms time window (Langeslag & Sanchez, 2017). Mean amplitude measures at electrodes F3, Fz, F4, C3, Cz, C4, P3, Pz, and P4 for each condition were submitted to a rmANOVA with factors Condition (positive reappraisal of partner, reappraisal of sexual desire decline, sexual imagery, no regulation), Caudality (frontal, central, parietal), and Laterality (left, midline, right). Only effects involving the factor Condition are reported since those are relevant to the research questions. Significant main and interaction effects were followed-up by paired-samples t-tests comparing each of the three regulation conditions with the no regulation condition, because those comparisons were relevant to the research questions. The LCQ-III items scores were analyzed using an rmANOVA

with the factors Direction (up-, down-regulation), Person (self, people), and Love Type (sexual desire, infatuation, attachment).

When applicable, degrees of freedom were corrected with the Greenhouse–Geisser correction. The F values, the uncorrected *dfs*, the epsilon ( $\epsilon$ ) values, corrected probability levels, and effect sizes ( $\eta_p^2$ ) are reported. A significance level of 5% (two-sided) was selected and Fisher’s least significance difference (LSD) procedure was applied. This procedure controls type I error rate by conducting follow-up tests for significant main and interaction effects only. Effect sizes (Cohen’s *d*) are reported for all *t*-tests.

## Results

### Participant characteristics

Twenty-three participants (92%) had opposite sex partners, one male participant (4%) had a same-sex partner, and one female participant (4%) had a genderqueer partner. Five participants (20%) were married to their partner, eleven (44%) were cohabitating but not married to their partner, and nine (36%) were neither married to nor cohabitating with their partner. The average relationship duration was 51.7 months ( $SD = 38.3$ , range = 24.0–204.0). Average satisfaction in sex life with partner was 7.4 ( $SD = 1.3$ , range = 5.0–9.0). The mean score for change in sexual desire for partner over the course of the relationship was 5.9 ( $SD = 1.7$ , range = 2.0–9.0), which was significantly different from 5 (5 = neutral),  $t(24) = 2.8$ ,  $p = .006$ , Cohen's  $d = .55$ , suggesting that participants' sexual desire for their partners increased over the course of their relationships.

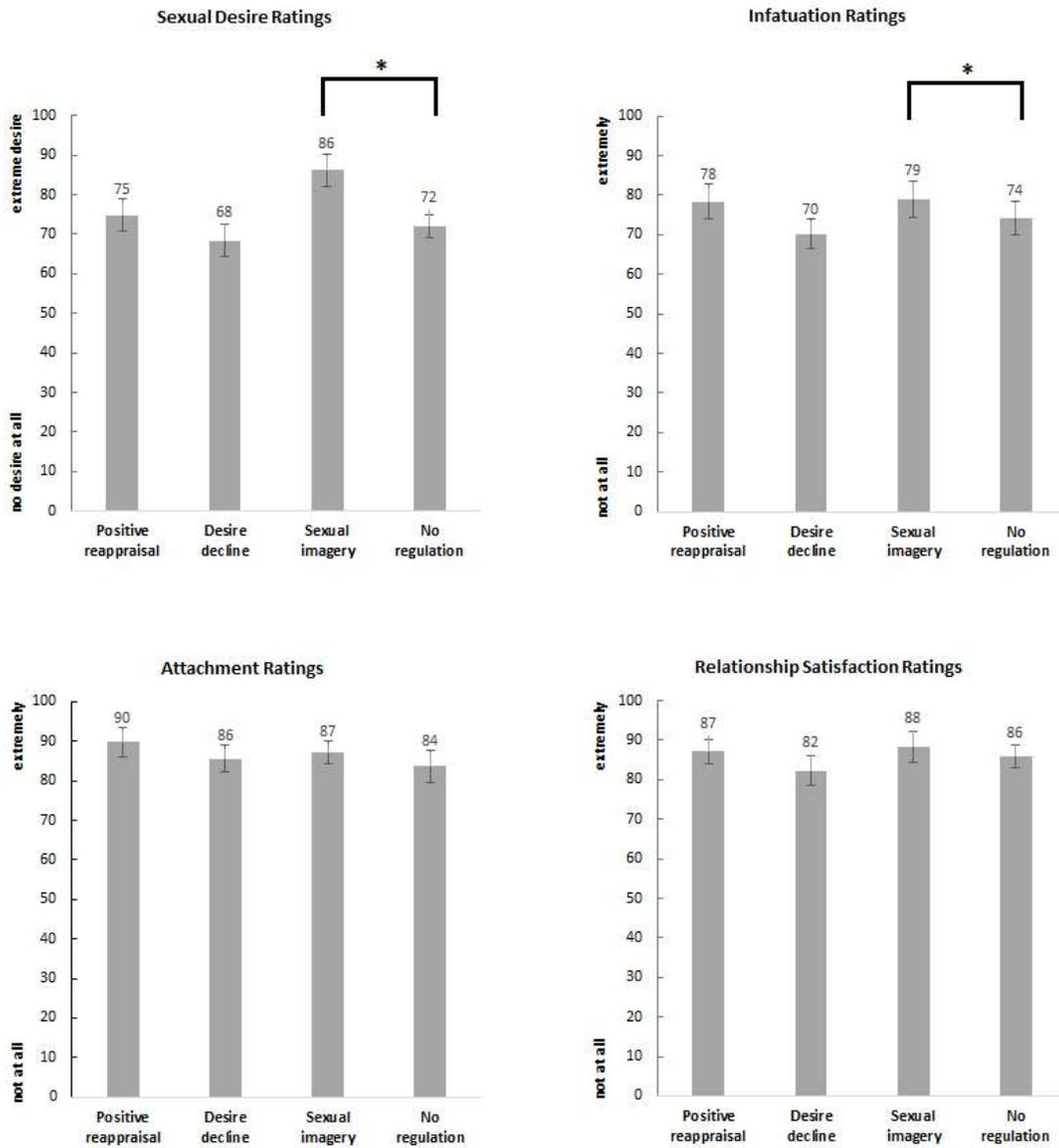
The mean SDI-2 strength of sexual desire for partner score was 5.8 out of 8 ( $SD = 1.6$ , range = 2.2–7.8), and the mean SDI-2 frequency of sexual desire for partner score was 4.5 out of 7 ( $SD = 1.3$ , range = 2.0–7.0). The mean RDAS score was 3.8 out of 5 ( $SD = 0.4$ , range = 2.8–4.6) which indicates a moderate level of relationship quality and satisfaction. The mean IAS infatuation score was 2.9 out of 7 ( $SD = 0.9$ , range = 1.3–5.0), and the mean IAS attachment score was 5.9 out of 7 ( $SD = 0.5$ , range = 5.1–6.7). These data show that participants experienced relatively low levels of infatuation and relatively high levels of attachment and for their partners prior to the regulation task, which is the expected pattern in long-term relationships (Langeslag et al., 2013).

## Ratings

See Fig. 2 for the ratings. For the sexual desire ratings, the main effect of Condition was significant,  $F(3,72) = 10.8$ ,  $\epsilon = .73$ ,  $p < .001$ ,  $\eta_p^2 = .31$ . Follow-up tests showed that participants felt more sexual desire for their partners after sexual imagery than after no regulation,  $p < .001$ , Cohen's  $d = .81$ . Reappraisal of sexual desire decline did not change sexual desire for the partner compared to no regulation,  $p = .32$ , Cohen's  $d = .18$ , and neither did positive reappraisal of the partner,  $p = .33$ , Cohen's  $d = .14$ .

For the infatuation ratings, the main effect of Condition was also significant,  $F(3,72) = 4.3$ ,  $\epsilon = .73$ ,  $p = .019$ ,  $\eta_p^2 = .15$ . Follow-up tests showed that participants felt more infatuated with their partners after sexual imagery than after no regulation,  $p = .029$ , Cohen's  $d = .22$ . Reappraisal of sexual desire decline did not change how infatuated participants were with their partners compared to no regulation,  $p = .24$ , Cohen's  $d = .18$ , and neither did positive reappraisal of the partner,  $p = .07$ , Cohen's  $d = .20$ .

There was no main effect of Condition for the attachment ratings,  $F(3,72) = 2.3$ ,  $\epsilon = .80$ ,  $p = .11$ ,  $\eta_p^2 = .09$ , or for the relationship satisfaction ratings,  $F(3,72) = 2.6$ ,  $\epsilon = .65$ ,  $p = .09$ ,  $\eta_p^2 = .10$ .



**Fig. 2** Mean sexual desire, infatuation, attachment, and relationship satisfaction ratings, error bars indicate standard errors of the mean. Regulation strategies were only compared to the no regulation condition, not to each other. \* indicates  $p < .05$ .

To test whether sexual imagery is more effective for some people than for others (e.g., people who have low vs. high sexual desire, or low vs. high relationship satisfaction), Pearson correlation coefficients were computed between the difference in

sexual desire ratings between the sexual imagery and no regulation conditions and the average score on several questionnaire items and questionnaires. Pearson correlation coefficients were also computed between the difference in infatuation ratings between the sexual imagery and no regulation conditions and the average score on several questionnaire items and questionnaires. See Table 1 for the correlations. We found no evidence of individual differences in the effectiveness of sexual imagery to increase sexual desire. There was a negative correlation between infatuation increase due to sexual imagery and the SDI-2 frequency of desire score,  $r(23) = -0.43, p = .033$ . This suggests that the lower the frequency of sexual desire for the partner, the more effective sexual imagery was for increasing infatuation for the partner.

Table 1

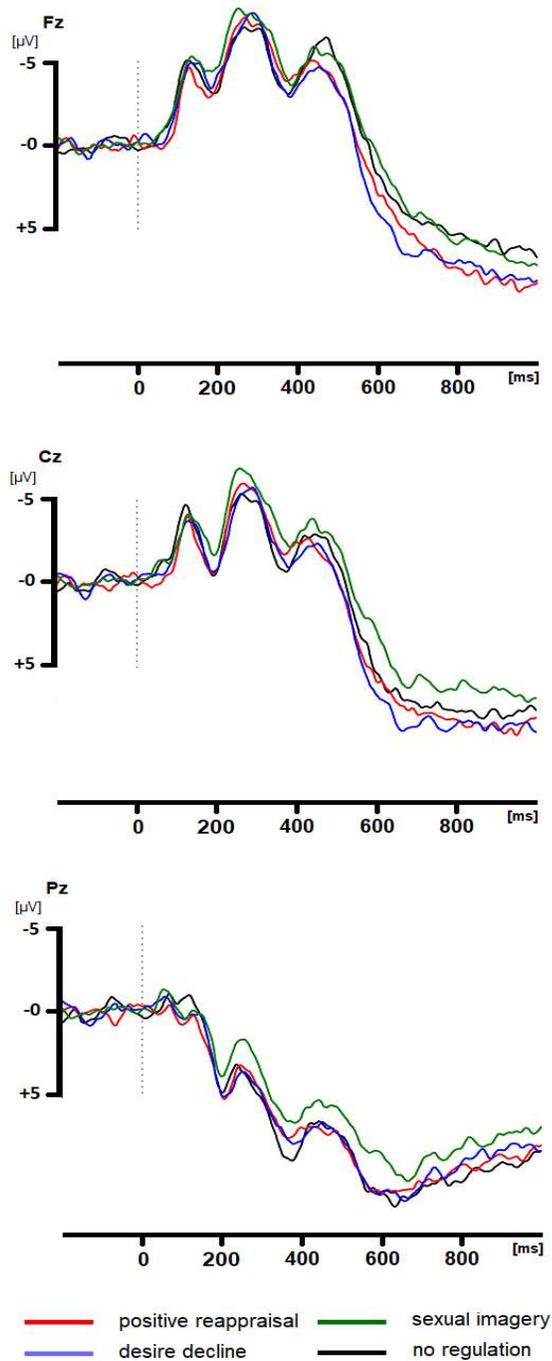
*Pearson correlation coefficients between the difference in sexual desire and infatuation ratings between the sexual imagery and no regulation conditions and the average score on several questionnaire items and questionnaires.*

	Sexual Desire	Infatuation
Length of relationship	-0.35	-0.14
Sex life satisfaction	0.00	-0.24
Change in desire	0.05	-0.09
Strength of desire (SDI-2)	-0.25	-0.03
Frequency (SDI-2)	-0.06	-0.43*
Infatuation (IAS)	-0.15	-0.16
Attachment (IAS)	0.07	0.17

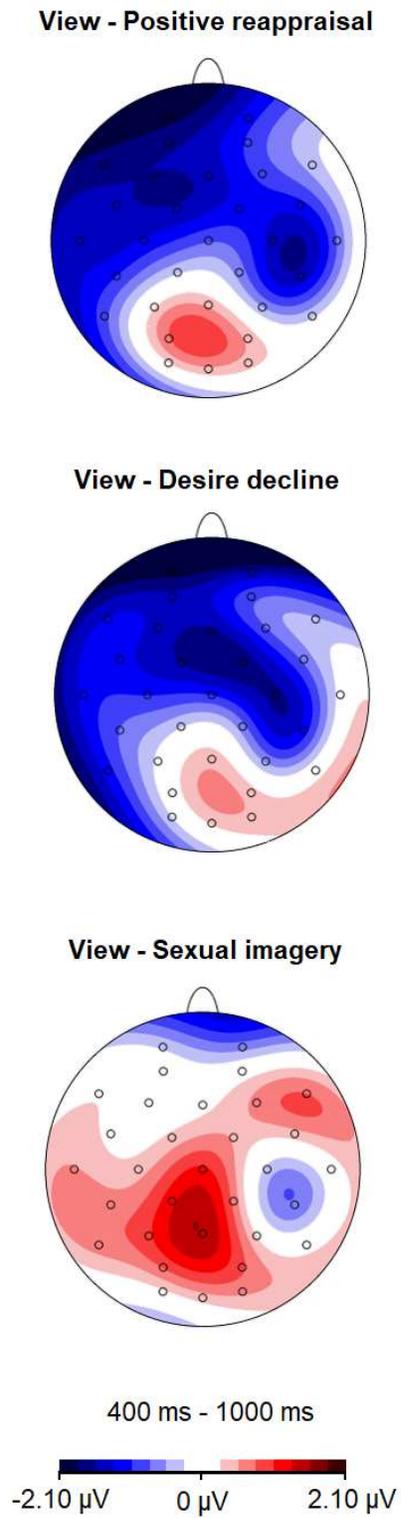
\*Correlation is significant at the 0.05 level (2-tailed).

**ERPs**

See Fig. 3 for the ERPs in response to the partner pictures and Fig. 4 for the scalp topographies of the regulation effects. In the 400-1000ms time window, none of the effects involving the factor Condition were significant, all  $F_s \leq 1.7$ , all  $p_s \geq .370$ .



**Fig. 3** Event related potential (ERPs) in response to the partner pictures at electrodes Fz, Cz, and Pz, in each of the regulation conditions. Positive amplitude plotted downward.



**Fig. 4** Scalp topographies of the regulation effects in the 400-1000 ms time window.

**Perceived ability to regulate types of love**

The mean score of the LCQ-III was 5.5 ( $SD = 1.1$ ). See Table 1 for the mean score on each of the items of the LCQ-III. There were main effects of Direction,  $F(1,24) = 6.8, p = .016, \eta_p^2 = .22$ , and Person,  $F(1,24) = 7.2, p = .013, \eta_p^2 = .23$ , which were modulated by a significant Direction x Person x Love Type interaction,  $F(2,48) = 5.9, \epsilon = 1.0, p = .005, \eta_p^2 = .20$ . Follow-up tests showed that participants thought that they were better at up- than down-regulating infatuation,  $t(24) = 3.2, p = .003$ , Cohen's  $d = 0.8$ , and that people in general were better at up- than down-regulating attachment,  $t(24) = 2.5, p = .019$ , Cohen's  $d = 0.5$ . Follow-up tests also showed that participants thought they were better at up-regulating infatuation,  $t(24) = 2.9, p = .008$ , Cohen's  $d = 0.4$ , but worse at down-regulating infatuation,  $t(24) = -2.5, p = .019$ , Cohen's  $d = 0.5$ , than people in general. Additionally, participants felt they were worse at up-regulating attachment than people in general,  $t(24) = 2.9, p = .008$ , Cohen's  $d = 0.6$ . Finally, follow-up tests showed that participants thought people were better at up-regulating sexual desire,  $t(24) = 2.8, p = .010$ , Cohen's  $d = 0.7$ , and attachment,  $t(24) = 3.6, p = .001$ , Cohen's  $d = 0.8$ , than infatuation.

Table 1  
*Mean scores on the Items of the Love Control Questionnaire III (LCQ-III)*

Item	Construct	Statement	M	SD
1	Sex-Up-Self	When I want to, I can increase how much sexual desire I feel.	5.7	2.1
2	Sex-Up-People	If they want to, people can increase their sexual desire.	6.3	1.7
3	Sex-Down-Self	I can purposefully decrease how much sexual desire I feel.	5.0	2.2
4	Sex-Down-People	People can deliberately decrease their sexual desire.	5.7	2.1
5	Infatuation-Up-Self	I can make feelings of infatuation more intense.	5.8	1.8
6	Infatuation-Up-People	People can enhance feelings of infatuation at will.	5.0	2.0
7	Infatuation-Down-Self	I can reduce the intensity of infatuation at will.	4.1	2.4
8	Infatuation-Down-People	People can make feelings of infatuation less intense.	5.2	2.2
9	Attachment-Up-Self	I can intentionally enhance feelings of attachment.	5.5	2.5
10	Attachment-Up-People	People can make feelings of attachment more intense.	6.6	1.9
11	Attachment-Down-Self	I can make feelings of attachment less intense.	5.1	2.2
12	Attachment-Down- People	People can intentionally reduce the intensity of attachment.	5.4	2.1

*Note.* The items were presented to participants in a pseudorandom order and the response scale ranged from 1 (*totally disagree*) to 9 (*totally agree*).

## Discussion

Previous research has shown that regulation can be used to change the intensity of current feelings of romantic love (Langeslag & Sanchez, 2017; Langeslag & Van Strien, 2016). The study's primary goal was to investigate three regulation strategies that could be used to increase sexual desire in long-term relationships: positive reappraisal of partner, reappraisal of sexual desire decline, and sexual imagery. Participants who were in a long-term relationship performed these three regulation strategies along with no regulation before passively viewing pictures of their partner. This task resembled everyday life, in that people in long-term relationships who experience diminished sexual desire may wish to increase their sexual desire for their partner before seeing (interacting?) with their partner. In the current study, thinking about hypothetical sexual scenarios (i.e., sexual imagery) involving the partner increased sexual desire for and infatuation with the partner.

We expected that all three regulation strategies would increase feelings of sexual desire for the partner. Participants had more sexual desire for their partner after performing sexual imagery (e.g., "Imagine you and your partner having sex"), but there was no change in intensity of sexual desire for their partner after positive reappraisal of partner and reappraisal of sexual desire decline strategies, so our hypothesis is only partially confirmed. As a result, positive reappraisal of partner and reappraisal of sexual desire decline do not seem to be effective up-regulation strategies for sexual desire. Surprisingly, while sexual desire typically declines over time in relationships (Clement, 2002; Herbenick et al., 2014), participants in our sample reported increased sexual desire over the course of their relationships. This could be due to memory bias when

retrospectively reporting, where people can misremember and misjudge the past as more positive or negative than it actually was and sometimes referred to as “rosy retrospection” (Mitchell & Thompson, 1994; Schacter, Chiao, & Mitchell, 2003). Given this consideration, it still may be beneficial to increase sexual desire.

While positive reappraisal of the partner did not increase sexual desire for the partner as expected, previous studies have shown that positive reappraisal is used for maintaining long-term relationships (Langeslag & Van Strien, 2016) and that relationship satisfaction is positively associated with sexual satisfaction (Brezsnyak & Whisman, 2004; Byers, 2005; Langeslag & Van Strien, 2016). Also, even though reappraisal of sexual desire decline did not increase sexual desire for the partner, therapists have found that relieving sexual anxiety can release inhibition and increase sexual desire (Mintz et al., 2017), and researchers have found that reinterpreting an emotion and accepting it without judgement (e.g., reappraisal of sexual desire decline) can decrease negative emotional experiences and increase positive affect (Hofmann et al., 2010; Webb et al., 2012). It is plausible that reappraisal of sexual desire decline prompts (i.e., “It’s normal for sexual desire to diminish over time”) simply induced neutral thoughts, neither relieving negative or increasing positive thoughts about sexual desire decline. The effectiveness of sexual imagery for increasing sexual desire for the partner extends previous empirical findings in which fantasizing about a partner increases sexual desire (Birnbaum et al., 2018) by focusing the effectiveness in long-term relationships exclusively. In short, sexual imagery could be used as an up-regulation strategy to maintain or increase sexual desire in long-term relationships.

The second goal of the study was to investigate whether the three strategies increase infatuation, attachment, and relationship satisfaction in long-term relationships. We expected that reappraisal of sexual desire decline and sexual imagery would increase infatuation and attachment for the partner. Sexual imagery made participants feel more infatuated with their partner but did not make them feel more attached, partially confirming our hypothesis. Reappraisal of sexual desire decline did not increase infatuation nor attachment, which was opposite of our hypothesis. We also expected that positive reappraisal would increase feelings of attachment, but not infatuation for the partner (Langeslag & Van Strien, 2016). Our hypothesis is in line with previous findings in which positive reappraisal did not increase infatuation for the partner. However, in contrast to our hypothesis, positive reappraisal of partner did not increase feelings of attachment for the partner. Although positive reappraisal was previously shown to be an effective up-regulation strategy for attachment (Langeslag & Van Strien, 2016), in context of this study, it does not appear to be an effective strategy. It could be that the effects typically induced by positive reappraisal may have been overshadowed by sexual imagery having favorable effects on infatuation, particularly given that attachment is a calm feeling of emotional bonding whereas infatuation is an overwhelming, amorous feeling (Langeslag et al., 2013). Also, since participants also reported to feel relatively high levels of attachment, it may be that our hypothesis about positive reappraisal was not supported due to a ceiling effect. We further expected to find that all three regulation strategies would increase relationship satisfaction, but none of the three regulation strategies did. Considering participants reported to feel relatively high levels of relationship satisfaction, it may be that our hypothesis about relationship satisfaction also

was not supported due to a ceiling effect. It would be interesting to examine in a future study whether these strategies would be beneficial for those reporting low relationship satisfaction.

The third goal of the study was to investigate whether the three strategies would influence motivated attention to the partner, as indicated by the LPP amplitude. We expected that all three strategies would increase the LPP amplitude in response to a picture of the partner. Contrary to our hypothesis, the three regulation strategies did not change the LPP amplitude in response to partner pictures between 400 and 1000 ms time window. So we did not find any evidence that the three strategies increased motivated attention for a long-term partner.

A strength of the current study is the experimental manipulation of strategy use. Instead of assessing associations between spontaneous strategy use and outcome variables related to increased sexual desire for the partner, we manipulated strategy use within participants in a regulation task and tested how that affected the outcome variables, which allows for demonstrating causality (Goodwin, 1998). A limitation of manipulating strategy use within participants, however, is that it only allowed for assessment of the short-term effects of regulation. In order to evaluate which regulation strategies would best help people increase sexual desire, it would be essential to consider both the short-term and long-term effects. Another potential limitation of the current study is that the majority of participants were women. It was difficult to recruit men, perhaps due to men being less likely to participate in a study about sexual desire than women. For this reason, we had to

sacrifice gender balance in favor of reaching the intended sample size. Even though the current results may be more generalizable to women than men, it may be women who might benefit most from up-regulating sexual desire as they report low sexual desire more often than men (Mintz et al., 2017).

To conclude, because diminished sexual desire is a common concern for couples in long-term relationships, up-regulation of sexual desire may help maintain or increase sexual desire for the partner. This is particularly important given conflicts about sex are concerns that often bring couples to therapy (McCarthy & Wald, 2015). Notably, another benefit is that up-regulation of sexual desire using sexual imagery can be used intrapersonally. Being able to up-regulate sexual desire for a partner privately can help couples avoid potential distress in their relationship that may arise when one partner discloses diminished sexual desire for the other partner. In addition to helping individuals who experience diminished sexual desire, it could also be beneficial for individuals who are looking for ways to keep their sexual relationship healthy and intact. Sexual imagery could also be used to increase feelings of infatuation for the partner, which typically decreases over time (Langeslag et al., 2013). As can be seen, up-regulation of sexual desire has important implications in everyday life and in clinical settings, such as maintaining the sexual desire aspect of relationships, increasing love feelings, and preventing or reducing relationship distress due to diminished sexual desire for the partner, just to name a few. Given the clear benefits, up-regulation of sexual desire is worthy of further investigation.

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## Appendix

### Regulation Prompts

#### *Positive Reappraisal of the Partner*

1. Think of time when your partner showed respect for you.
2. Think about a value you appreciate about your partner.
3. Think of some ways your partner acts nice towards you.
4. Think of ways in which your partner supports you.
5. Think of a time when your partner made your day better.
6. Think of something you and your partner both like.
7. Think of something funny your partner says.
8. Think of something nice that your partner has said to you.
9. Think of a time when your partner complimented you.
10. Think of a way your partner makes you feel special.
11. Think of some of your partner's hobbies that you like.
12. Think of something your partner understands about you.
13. Think of a goal you and your partner have in common.
14. Think of something fun your partner participates in.
15. Think of a time your partner looked great.
16. Think of a habit of your partner that you like.
17. Think of something sweet your partner did.
18. Think of an outfit of your partner that you like.
19. Think about a time when your partner was nice to you.
20. Think of a time when your partner gave you a nice gift.
21. Think of a time when your partner helped you.
22. Think of something enjoyable your partner likes to watch on TV.
23. Think of a place your partner likes to travel.
24. Think of a physical feature that you like about your partner.
25. Think of a personality trait of your partner that you find appealing.
26. Think of something your partner said that made you feel loved.
27. Think of time your partner made you laugh.
28. Think of something your partner is really good at.
29. Think of a time when your partner stood up for you.
30. Think of a time your partner pleasantly surprised you.

#### *Reappraisal of Sexual Desire Decline*

1. It's normal for sexual desire to decrease over time in a relationship.
2. Sexual desire often diminishes over time.
3. It's normal for passion to decline as the chemical high of early attraction diminishes.
4. It's typical for libido to decline in long-term relationships.
5. It's typical for sexual desire to decrease as emotional bonding increases.
6. People often experience diminished passion in long-term relationships.
7. It's okay for sexual desire to decline while comfort in relationship increases.

8. Sexual desire often decreases while companionship increases.
9. People often experience diminished passion while other types of bonding increase.
10. It's typical for sex drive to decline when couples have been together for a while.
11. It's normal for passion to decrease in a long-term relationship.
12. It's normal for sexual desire to decrease as the infatuation wears off.
13. It's normal for sexual desire to decline as couples begin to bond in other ways.
14. People often experience reduced sexual desire for a long-term partner.
15. A diminished sex drive doesn't mean there's a problem with the relationship.
16. It's normal for sex drive to decrease even if the relationship is good.
17. It's typical for couples to experience decreased libido over time.
18. Sexual desire often decreases when attachment increases.
19. It's okay to have a lower libido than when you first met.
20. It's okay to feel low sexual desire while still feeling close to your partner.
21. It's normal for sexual desire to decline even when there's emotional intimacy.
22. It's okay for passion to decrease even when you enjoy being together.
23. People can experience a lack of passion even when the relationship is fine.
24. It's typical to experience reduced libido in long-term relationships.
25. It's normal for sex drive to decrease over the course of the relationship.
26. Reduced sexual desire doesn't necessarily mean a loss of love.
27. Diminished passion doesn't necessarily indicate a bad relationship.
28. It's okay to experience low sexual desire for a long-term partner.
29. As relationships progress, sexual desire often decreases.
30. Even in good relationships, couples often experience loss of passion.

### ***Sexual Imagery***

1. Imagine your partner sexually teasing you around others.
2. Imagine something naughty your partner could send you while at work.
3. Imagine being intimate with your partner later.
4. Imagine something your partner could say to make you feel sexy.
5. Imagine your partner wearing something you find sexy.
6. Imagine something playful your partner could do to turn you on.
7. Imagine a part of your partner's body that you find sexy.
8. Imagine being naked with your partner.
9. Imagine a room that you would like to have sex with your partner in.
10. Imagine your partner sexually pleasing you without intercourse.
11. Imagine a piece of furniture you would like to have sex with your partner on.
12. Imagine something your partner could do with their mouth to turn you on.
13. Imagine something your partner could do with their hands to turn you on.
14. Imagine something you would like your partner to do to you during sex.
15. Imagine something you would like to do to your partner during sex.
16. Imagine you and your partner having a make-out session.
17. Imagine you and your partner having sex.
18. Imagine you and your partner having orgasms at the same time.
19. Imagine you and your partner engaging in your favorite sexual fantasy.
20. Imagine your partner kissing a part of your body.

21. Imagine something spontaneous your partner could do to turn you on.
22. Imagine you and your partner engaging in your favorite foreplay.
23. Imagine something naughty your partner could say during sex.
24. Imagine you and your partner sexually teasing each other.
25. Imagine a sex position that you would like to try with your partner.
26. Imagine sexting with your partner.
27. Imagine a sex toy that you and your partner could try.
28. Imagine you and your partner watching something erotic together.
29. Imagine something sexual you've always wanted to try with your partner.
30. Imagine a place you'd like to have sex with your partner.