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Preoccupation in an early-romantic relationship predicts experimental pain relief

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Abstract

Objective—Individuals involved in the early stages of a passionate romantic relationship can be consumed by the experience and report emotional dependence and constant focus on their romantic partner. A few studies have shown that viewing pictures of a romantic partner can significantly reduce experimental pain. The strength of the effect, however, varies substantially between individuals. To study why some individuals experience significant pain reduction when looking at a picture of their partner, we examined partner preoccupation. We hypothesized that a greater degree of preoccupation in the early stages of a romantic relationship would be associated with greater analgesia during a pain induction task.

Methods—Participants were shown pictures of their romantic partner or an equally attractive and familiar acquaintance while exposed to low, moderate or high levels of thermal pain. Participants were also asked to rate how much time they spent thinking about their romantic partner during an average day. Degree of preoccupation was defined as the percentage of time participants spent thinking about their partner on an average day.

Results—In two separate experiments, viewing pictures of a romantic partner produced an analgesic effect. The degree of pain relief was positively correlated with partner preoccupation. The results suggest that preoccupation with a romantic partner during early stage romantic love is a predictor of pain relief when viewing pictures of the beloved.

Keywords

pain; pain-reduction; preoccupation; romantic partner

Introduction

Romantic love is considered a nearly universal experience involving distinct and identifiable emotions and behaviors. The early stages of a new romantic love relationship involve

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heightened energy, impulsivity and euphoria (1–3). Tennov (1979) describes the early stages of love as a cognitive and emotional state involving emotional attachment and obsession with another person (4). Individuals involved in a passionate romantic relationship can be consumed by the experience and report emotional dependence, desired closeness and constant focus on their romantic partner (1–5). According to Fisher and colleagues (2005), a principal characteristic of human romantic love is "intrusive, obsessive thinking about the beloved" (6). The concept of obsession with the partner may not be unique to humans. Birds and other animals exhibit focused attention, obsessive following, and possessive mate-guarding in the early courtship routines (7). Despite being recognized as a central feature of early-stage romantic love, romantic partner obsession has not been well studied.

Preoccupation may provide insight on how to harness romantic love into a way to cope with chronic pain. The ability of psychological states, such as romantic love, to reduce pain is of interest given the great burden that chronic pain places on society. Chronic pain impacts over 100 million adults in the United States alone and is estimated to cost over 500 billion dollars per year (8). While current pain treatments mainly rely on analgesic properties of opioids, there are concerns about the long-term effectiveness of prescription medications and a growing awareness of their adverse effects, including misuse and addiction (9). The ability to understand factors that influence analgesia is important as we look for non-pharmacological mechanisms to reduce chronic pain.

Given its complex nature, there are many aspects of romantic love that could affect the perception of pain, including reward system activation, attachment/oxytocin systems, social support, and distraction. The overall effect of romantic love on pain has been previously studied. Viewing pictures of a romantic partner has been shown to reduce the experience of pain (10,11,12). The analgesic effect of looking at one's beloved is perhaps not surprising, given that the subcortical reward and motivation regions involved in passionate love (2, 13–17) are also known to play an important role in the analgesic process (18–20). Indeed, two functional neuroimaging studies to date have shown that the analgesic properties of romantic love correlate to activity in the limbic and reward regions of the brain (11,12). In both of those studies, self-reported pain resulting from a thermal stimulus was significantly reduced when participants were viewing a picture of their romantic partner. The pain relief is significantly stronger than when participants view pictures of an inanimate object, stranger, or attractive acquaintance, and stronger than analgesia resulting from a cognitive distraction task. While those studies reveal an overall significant analgesic effect associated with viewing pictures of a romantic partner, the strength of the effect can vary substantially between individuals. In this study, therefore, we sought to explain the variability in the analgesic effect of romantic love by examining preoccupation with the romantic partner. We hypothesized that a higher degree of preoccupation would be associated with a greater analgesic effect.

Methods

This report utilizes data collected from two independent studies. Study 1 involves previously unpublished data from a study conducted specifically to test the degree to which evoked feelings of love would result in pain relief. Study 2 is a post-hoc analysis and was used as an

independent validation of the hypothesis. Neuroimaging data from Study 2 have been previously published (11).

Participants

Across two studies, a total of 27 individuals participated in the experiment. Participants were in their first 9 months of a romantic relationship. In an initial pre-screening phone call, all participants qualitatively described their relationship as monogamous, passionate, and romantic. All participants additionally completed the 15-item version of the Passionate Love Scale (PLS; 5) at their laboratory visit. The PLS contains statements regarding how individuals feel about their partner, on a scale from 1 (untrue) to 6 (true). The responses resulted in a mean PLS score on a range of 1 (not passionate at all) to 6 (highly, recklessly, and wildly passionate). The 15 participants (11 female, age-range: 18–22) in Study 1 had a mean PLS score of 4.9 (SD=0.6, range = 3.7–5.5). The 12 participants (6 female, age-range: 19–21) in Study 2 had a mean PLS score of 4.8 (SD=0.6, range = 4.1–5.9). All volunteers gave written informed consent and were monetarily compensated for their participation. Study procedures were approved by the Institutional Review Board at Stanford University School of Medicine.

Assessing obsession with romantic partner

The sole predictor used in the analyses was preoccupation with the romantic partner. We utilized a single-item questionnaire that assesses daily preoccupation with the partner. As part of the debriefing questionnaire, all participants were asked the following question: “What percentage of the day is your partner on your mind?” and were prompted to respond with a percentage score from 0 to 100. Partner preoccupation was defined as the amount of time participants spent thinking about their romantic partner during an average day.

Experimental Paradigm

Prior to arriving for the experimental session, all participants across both studies were asked to send three digital pictures of their romantic partner and three digital pictures of their acquaintance. Participants were instructed that the acquaintance chosen was to be of the same gender as the romantic partner. Pictures were cropped to display only the face. Participants rated attractiveness for both their romantic partner and their acquaintance, on a scale from 0–10. In Study 2, eight college students (not involved in any other part of the study, and blinded to whether pictures were of the partner or acquaintance) also rated the attractiveness of all pictures.

Thermal stimuli were presented with a Medoc (Durham, NC) Advanced Thermal Stimulator 3X3 cm Peltier contact thermode. The thermode allows for precise control of heat stimuli and can produce temperatures up to 51 degrees Celsius. Pain was rated on a 0 – 10 numerical scale, with 0 being “no pain at all” and 10 being “worst pain imaginable.”

Study 1—We sought to examine the effect of preoccupation on a range of pain-level stimuli. We first determined low (3/10), moderate (5/10) and high (7/10) levels of pain by exposing participants to 10-second heat blocks on their left hand. Following each thermal presentation, participants provided a 0 – 10 pain rating. The first heat stimulus presentation

was set at a non-painful temperature of 42 degrees Celsius. Subsequent stimuli were increased by 1 degree Celsius. Heat stimuli were presented until the participant rated their maximum (10/10) pain, or stopped the stimulus with a participant-controlled button. After reaching the 10/10 pain level, the temperatures for low, moderate, and high pain levels were repeated and verified to elicit the intended level of pain.

After temperature determination, participants began the experimental study. Following the protocol employed by Aron and colleagues (2), participants were shown pictures of either their partner or their acquaintance, and were asked to focus on the picture and think only about the displayed person. Faces of the romantic partner were presented in the romantic partner condition, while faces of the equally attractive and familiar acquaintance were presented in the acquaintance condition. Each picture presentation was co-administered with a thermal stimulus on the right hand at the previously-determined low-, moderate-, or high-pain temperatures. The ramp rate for all thermal stimuli was 10°C/second. Each condition and temperature was pseudo-randomly presented, resulting in a total of 36 trials (18 trials per condition). Following each trial, the participant rated his or her level of pain using the 11-point numerical rating scale.

Between each trial, we allowed time for the skin to cool to ensure there was no cumulative thermode effect that could alter pain levels. In order to minimize any sensory and affective carry-over, participants completed a mental arithmetic task for 10 seconds between each trial. Participants were shown a 4-digit number and were asked to verbally count backwards by 7’s as quickly and accurately as possible.

Study 2—We first determined what temperatures would produce no (0/10), moderate (4/10), and high (7/10) levels of pain. Unlike Study 1, Study 2 had no low-level pain condition. Participants were exposed to 15-second heat blocks on their left hand. Following each trial, participants provided a 0 – 10 rating. The heat stimulus started at a non-painful temperature of 40 degrees Celsius, and was increased by 1 degree Celsius with each successive stimulus presentation. Heat stimuli were presented until participants rated their maximum (10/10) pain, or stopped the stimulus with a participant-controlled button. After reaching the 10/10 pain level, the temperatures for no-, moderate- and high-pain levels were repeated to verify the intended level of pain.

As described previously (11), participants followed Aron and colleagues’ protocol (2), and completed three distinct tasks: an acquaintance baseline condition, a romantic partner active condition, and distraction control condition in a 3T GE Signa system magnetic resonance imaging (MRI) scanner. During each condition, participants received a thermal stimulus at no pain (32 degrees Celsius) and their previously identified 4/10 or 7/10 temperatures. Each condition by pain-level combination was presented 6 times, yielding 54 pseudo-randomly ordered trials. Distraction-task trials were not included in analyses. MRI data were not analyzed for this report.

Between each trial, participants completed a mental arithmetic task for 13 seconds. Participants were presented with a 4-digit number and were asked to verbally count backwards in decrements of 7 as quickly and accurately as possible.

At the end of the entire paradigm, participants were asked to identify the purpose of the experiment. A response was counted as correct if the participants in any way identified pain as the outcome and the pictures as the experimental variable. This question was designed to account for demand characteristics in the experiment.

Behavioral Analysis and Statistics

Pain ratings from each trial were averaged, resulting in a mean pain score per subject for each pain level and each condition of interest (acquaintance and romantic partner). To calculate the analgesic effect of the romantic partner task per individual, we subtracted the mean pain score in the romantic partner condition from the mean pain score in the acquaintance condition, and divided by the mean pain score in the acquaintance condition. This method yielded a percent pain reduction value, with 0 being no reduction in pain, and 100 being complete reduction of pain.

To determine the relationship between analgesia and the percentage of the day spent thinking about a romantic partner, we conducted a two-tailed Pearson's correlational analysis. All statistical analyses were conducted in SPSS v. 21 (IBM). Assumptions of normal distribution were assessed with the Shapiro-Wilk test.

Results

Mean self-reported pain by condition and stimulus intensity is presented in Table 1. No independent or dependent variables deviated significantly from normally distributed, as assessed with the Shapiro-Wilk test, so parametric tests were used for all analyses.

Study 1

Preoccupation with the romantic partner (percent time on mind) ranged from 15% to 90% (Mean = 60.7%, SD = 24.0). In order to characterize the effect of preoccupation with a romantic partner on overall pain reduction, we first collapsed low-, moderate- and high-pain trials. We found an overall pain reduction of 9.91% (SD = 11.56). This overall reduction was positively correlated ($r = 0.55$, $p = 0.035$) with the amount of time a romantic partner was on the participant's mind (Figure 1a). In investigating the pain levels separately, we found that low pain level analgesia (Mean = 16.56%, SD = 26.93) also positively correlated ($r = 0.512$, $p = 0.05$) with preoccupation. Moderate pain level analgesia (Mean = 5.09%, SD= 18.43) did not significantly correlate with preoccupation ($r = 0.444$, $p = 0.097$), though a non-significant trend was noted. High pain level analgesia (Mean = 8.101%, SD = 11.46) did not significantly correlate with preoccupation ($r = 0.005$, $p = 0.987$).

Participants found their partner significantly more attractive than their acquaintance ($t(14) = 2.87$, $p = 0.012$). Mean partner attractiveness was rated as 9.1 (SD = 0.8), and acquaintance attractiveness was rated as 7.8 (SD = 1.7). The difference in partner attraction and acquaintance attraction did not significantly correlate with overall pain reduction ($r = -0.269$, $p = 0.332$), or when low, medium, or high analgesia trials were examined separately ($r = -0.361$, $p = 0.186$; $r = -0.335$, $p = 0.222$; $r = 0.132$, $p = 0.639$).

Fifty-three percent of the participants correctly guessed the purpose of the experiment at the end of their participation. Those individuals correctly guessing the purpose of the experiment did not experience more analgesia than those individuals who guessed incorrectly ($t(11) = 1.15$, $p = 0.307$). Three participants from Study 1 were not included in this part of the analysis due to missing data.

Study 2

Preoccupation with the romantic partner ranged from 20% to 90% (Mean = 50.0%, SD = 23.1). In order to look at the effect of preoccupation with a romantic partner on overall pain reduction, we first collapsed all pain trials. In the romantic partner condition, we found an overall pain reduction of 29.5% (SD = 23.7). This reduction positively correlated ($r = 0.69$, $p = 0.014$) with the amount of time a romantic partner was on the participant's mind (Figure 1b). Moderate pain level analgesia (Mean = 39.1%, SD = 31.4) alone also positively correlated with the amount of time spent thinking about one's romantic partner ($r = 0.75$, $p = 0.005$). High pain level analgesia (Mean = 19.71% SD = 17.67) was not significantly correlated with preoccupation ($r = 0.504$, $p = 0.094$), though a non-significant trend was noted.

Participants in Study 2 also found their partner more attractive than their acquaintance ($t(11) = 4.103$, $p = 0.002$). Mean partner attractiveness was rated at 9.1 (SD = 0.9), while acquaintance attractiveness was rated at 6.9 (SD = 1.5). The difference in partner attraction and acquaintance attraction did not significantly correlate with overall pain reduction ($r = 0.24$, $p = 0.444$), moderate pain level ($r = 0.11$, $p = 0.740$), or high pain level ($r = 0.42$, $p = 0.172$). The eight blinded, independent raters of picture attractiveness observed no difference of attractiveness between the partner and acquaintance pictures ($t(22) = 0.54$, $p = 0.594$).

Sixty-seven percent of the participants correctly guessed the purpose of the experiment at the end of their participation. Those individuals correctly guessing the purpose of the experiment did not experience more analgesia than those individuals who guessed incorrectly ($t(10) = 1.41$, $p = 0.262$).

Discussion

In this analysis, we demonstrate that individuals who report spending more time thinking about their romantic partner in an early passionate relationship experience greater analgesia while viewing pictures of their partner than do lesser-preoccupied individuals. The positive association between partner preoccupation and pain reduction was seen in two separate studies. Preoccupation with the partner is one factor that predicts the analgesic effects of looking at a picture of a romantic partner.

When we examined the separate pain levels in post-hoc tests, we observed that the preoccupation and analgesia correlation was not consistently seen across levels of pain intensity. In Study 1, analgesia during low pain intensity trials was correlated with preoccupation. However, the correlation during moderate-intensity trials did not reach significance (r=0.444, p=0.097), and the correlation during high-intensity trials was not

significant (r = 0.005, p=0.987). In Study 2, preoccupation was correlated with analgesia in moderate-intensity trials, but did not reach significance with high-intensity trials (r = 0.504, p = 0.094). The lack of consistency between pain-levels across both studies may have been related to the variations in experimental protocols.

It is unclear by what mechanism preoccupation with the partner may lead to increased analgesic benefits. Two possible explanations are reward pathways and attention pathways. Distraction is another possible mechanism, though a previous neuroimaging study by our group showed that distraction-analgesia and love-analgesia appeared to operate via distinct pathways in the brain (11). While the hypothesis is untested, it is possible that individuals who are highly preoccupied with their partner may exhibit increased reward system processing when in the presence of a cue that reminds them of their partner. As it has previously been demonstrated that reward system activation produces analgesic effects (21), increased reward activity in highly preoccupied individuals may explain the analgesic effect we observed. A second explanation is that preoccupied individuals divert more attention to partner cues than do individuals who are less preoccupied. Attention is an important component of the experience of pain, and individuals who are more thoroughly distracted by other stimuli or cognitive tasks will experience less acute pain (22,23). Future studies should explore the neurobiological properties and mechanisms of preoccupation itself to determine whether preoccupation augments the reward systems or acts as a distraction to reduce pain.

Acevedo and Aron (24) used a factor analysis to examine obsession-related characteristics in Hatfield and Sprecher's 30-item Passionate Love Scale (5) while investigating the differences between early and long-term relationships. The obsessive quality of passionate romantic love was characteristic of young relationships, and generally did not persist as a relationship became long term. It is therefore not known if partner cues would elicit profound analgesia in long-term relationships. Nor is it known if the relationship between preoccupation with the partner and analgesia would persist beyond the early stages of a romantic relationship. Since we used a different (15-item) version of the scale in our study, we were unable to conduct the same factor analysis or use a subset of the Passionate Love Scale to assess preoccupation.

It is also important to note that preoccupation is only one factor of early-stage romantic love that can explain the variation of pain relief among individuals performing this task. Several other factors such as impulsivity, partner attractiveness, and degree of emotional dependence may interact with preoccupation or act independently to produce analgesia. Differences in attachment in different relationships can also lead to varying degrees of preoccupation. Preoccupation with a romantic partner in a healthy relationship may be one of positive emotional support; while in an unhealthy relationship, may turn into one of compulsion, addiction, and subsequent jealousy. Future studies should systematically isolate and examine other factors involved in different types of early romantic relationships.

There are some important limitations to note in this study. First, we used a measure of convenience to assess preoccupation with the romantic partner. The one-item questionnaire has not been validated as a measure of partner preoccupation. Therefore, obsession and preoccupation may be better assessed using other tools. While most validated obsession-

related questionnaires are clinical and related to obsessive compulsive disorder, Doron et al. (2012) have recently presented a 12-item measure that assesses obsessive-compulsive symptoms specific to relationships (25). Such scales may provide better information regarding the relationship between partner preoccupation and analgesia. In isolating preoccupation, we also tried to control for other factors involved in early romantic love such as attractiveness. While mean attractiveness did vary between romantic partner and acquaintance images, the difference did not significantly correlate with analgesia. Furthermore, objective raters found no difference in attractiveness between romantic partner and acquaintance images. However, finding a romantic partner attractive is a key feature of the euphoria associated with early romantic love, and isolating this aspect may be difficult for participants in self-report questionnaires. Another potential limitation with the study is that over half of the participants correctly guessed the nature of the experiment, thus raising issues of demand characteristics. We did not, however, find that correctly guessing the purpose of the experiment led to greater analgesia, so perhaps study demand characteristics did not seriously confound the results.

A major limitation to the study was the small sample size. While it may have been possible to collapse data across the two studies to achieve greater statistical power, there were distinct differences in the protocols that would make such collapsing difficult. We chose to not analyze the two studies combined both because of those protocol differences, and because running two separate tests increased our confidence that the results are replicable. Even with two small samples, we were able to see a significant relationship between partner preoccupation and analgesia.

It is unknown what these results may mean for individuals with chronic pain. We could hypothesize that a romantic relationship reduces the severity of chronic pain. However, while it is tempting to generalize the results of existing studies to real-world situations, we note that effects on evoked, acute pain may not translate to tonic, clinical pain. Future studies may explore how love-related analgesia reduces the severity of chronic pain, and integrate related lines of research such as pain and social support (26).

Preoccupation with the romantic partner is an important predictor of pain relief during a romantic analgesia task. The analgesic benefits of preoccupation may also extend beyond the context of love (27,28). Both pain and romantic love involve a complex integration of cognitive, sensory, affective, and motivation processes. Teasing apart the mechanisms of “natural” analgesic processes will not only allow us to construct a better understanding of pain in humans, but also help identify targets for new pain therapies.

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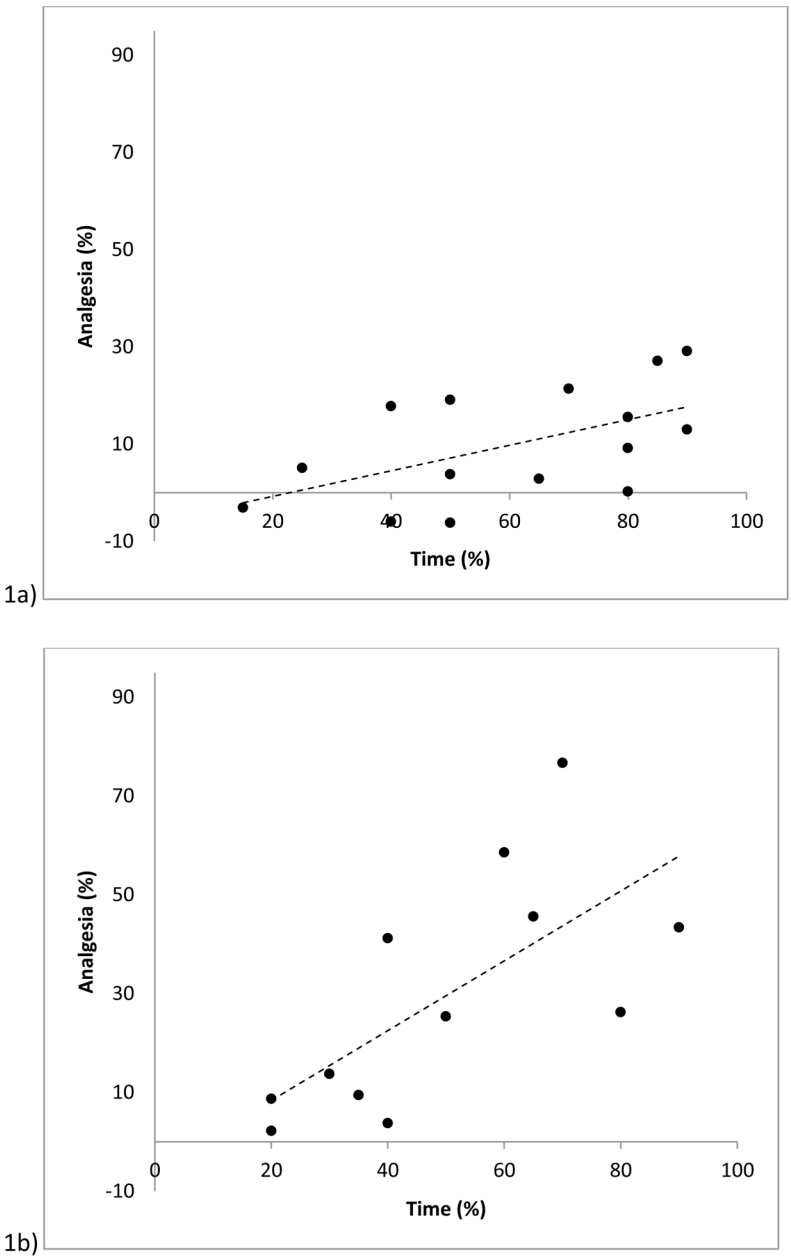

Figure 1.

presents the correlation between percent time on mind and percent analgesia resulting from viewing pictures of a romantic partner in study 1 (a) and study 2 (b).

Table 1

presents mean pain ratings at each condition and percent analgesia resulting from viewing pictures of a romantic partner and acquaintance. Standard deviations are indicated in parentheses.

Study 1:	**Low Pain (3/10)**	**Moderate (5/10)**	**High (7/10)**
Romantic Partner	2.19	4.62	7.07
Acquaintance	2.56	4.95	7.69
Analgesia	16.56% (26.9)	5.09% (18.4)	8.101% (11.5)
Study 2:	No Pain (0/10)	Moderate (4/10)	High (7/10)
Romantic Partner	0.04	2.49	5.90
Acquaintance	0.17	3.76	7.28
Analgesia	-	39.35% (31.41)	19.71% (17.7)