Regional brain activity during early-stage intense romantic love predicted relationship outcomes after 40 months: An fMRI assessment

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HIGHLIGHTS

► We followed up with participants from an fMRI study of early-stage romantic love.
► Follow-up assessed relationship status, happiness, and commitment 40 months later.
► Early-stage activations and deactivations in several regions predicted better outcomes.
► We discuss results in relation to reward, evaluation, mood, and emotion regulation.

ARTICLE INFO

ABSTRACT

Early-stage romantic love is associated with activation in reward and motivation systems of the brain. Can these localized activations, or others, predict long-term relationship stability? We contacted participants from a previous fMRI study of early-stage love by Xu et al. [34] after 40 months from initial assessments. We compared brain activation during the initial assessment at early-stage love for those who were still together at 40 months and those who were apart, and surveyed those still together about their relationship happiness and commitment at 40 months. Six participants who were still with their partners at 40 months (compared to six who had broken up) showed less activation during early-stage love in the medial orbitofrontal cortex, right subcallosal cingulate and right accumbens, regions implicated in long-term love and relationship satisfaction [1,2]. These regions of deactivation at the early stage of love were also negatively correlated with relationship happiness scores collected at 40 months. Other areas involved were the caudate tail, and temporal and parietal lobes. These data are preliminary evidence that neural responses in the early stages of romantic love can predict relationship stability and quality up to 40 months later in the relationship. The brain regions involved suggest that forebrain reward functions may be predictive for relationship stability, as well as regions involved in social evaluation, emotional regulation, and mood.

Neuroimaging studies of romantic love have investigated early-stage, intense romantic love [5,28,34,36] as well as longer-term romantic love [1,6,11,27,38]. However, little is known about how brain activations during early-stage romantic love are associated with relationship outcomes.

Several models speak to the long-term implications of early-stage relationship quality. The enduring dynamics model emphasizes the importance of the initial relationship stage, as dynamics tend to persist and predict later outcomes [16–18]. The disillusionment model [33] suggests that people initially over-idealizing their partner and relationship, and that this inevitably declines, which can lead to negative outcomes, although a certain level of idealization can be beneficial [24]. Finally, the emergent distress model downplays the importance of initial assessments as most couples initially feel positively, and focuses instead on negative factors that emerge as the relationship progresses [18].

Early stage love is associated with activations in dopamine-rich reward and motivation regions of the brain, particularly in the ventral tegmental area (VTA) and caudate. Romantic love past the early stage is not only associated with reward region activations (e.g., caudate and putamen, medial orbitofrontal cortex), but also elicits a much broader range of activations in areas rich in oxytocin, vasopressin, and opioids, which are important for social bonding [3,6,9,27].

Thus far the only neuroimaging study that has addressed the association between early stage intense romantic love and any later relationship stage has been Xu et al. [34] who scanned participants during early-stage and recontacted participants 18 months after scanning to assess relationship happiness. Xu et al. [34] found that activation of the subgenual cingulate and the superior frontal gyrus (while viewing images of the partner) during the initial scan was positively correlated with reported relationship happiness 18 months later. Consistent with the enduring dynamics model, the results suggested that the more rewarding a relationship was during the initial stage, the more likely it was to be rewarding in the future. However, those findings were limited in two key respects that the present study is able to address: (1) there were too few participants who had broken up at 18 months to permit reliable assessment of relationship stability, and (2) it was limited to only 18 months, which may not have been sufficient for processes such as disillusionment or emergent distress to appear.

The current study is a 40-month follow-up of these same participants, investigating the relationship between early-stage love brain activation and subsequent relationship longevity (whether participants were still together); the study also investigated happiness and commitment 40 months after initial assessment, influential relationship factors [4]. Strengths of this study were (a) it used an objective measure, fMRI activity and (b) it used a central measure, whether together or apart, which is a clear behavioral indicator. Although our sample size was modest, the results replicated other findings from other fMRI studies of relationship satisfaction and long-term love, and were consistent with other findings about positive social motivation [1,2,15].

1. Method

1.1. Participants

Participants were 18 Han Chinese right-handers (10 women) who at the time of scanning reported being intensely in love on a translated and slightly modified version of the Passionate Love Scale [see 34] and who were still in the early stages of their relationship. Relationship lengths at the time of the scan ranged from 1.3 to 13 months; $M = 6.54$, $SD = 3.19$. Participants' mean age at the time of the scan was 21.61 ($SD = 1.75$) and they were not taking psychoactive medications.

Forty months after the scan, we contacted participants via email and phone and asked them whether they were still with their partner. Of the original 18 participants, 12 (7 women) responded. For these 12, the average relationship length at the time of the scan was 5.78 months ($SD = 2.53$) and the average age was 21.5 ($SD = 1.62$). Analysis of variance tests showed that there were no significant differences in age, sex, relationship length, or any other variable assessed during early-stage between follow-up participants and those who could not be re-contacted, ps > .34.

1.2. Measures at 40 months after early-stage love fMRI scan

Of the 12 follow-up participants, 6 were still together with their partner and rated their current level of relationship happiness ("our relationship makes me very happy") as well as their current level of relationship commitment ("I am committed to maintaining my relationship with my partner") on a 1–7 scale.

1.3. fMRI scanning protocol during early-stage love

Baseline scanning was done on a 3 T Trio at the Beijing Center for Brain Research [see 34 for details]. Stimuli were (a) Partner: a headshot of their romantic partner; (b) Countback 1: a serial countback task presented after the Partner photo to prevent emotion spillover effect into the control Neutral condition; (c) Neutral: a headshot of a familiar, neutral acquaintance that was the same age and sex as their partner; (d) Countback 2: a serial countback task presented after the Neutral photo. Participants were asked to think of memories of their partner and acquaintance when they saw each respective image [see 34 for detailed protocol].

1.4. Analysis of fMRI data taken at the early stage of love

We used Statistical Parametric Mapping software (SPM2; Wellcome Department of Imaging Neuroscience, London, UK). Functional images were normalized to the SPM EPI template brain and realigned and smoothed with a Gaussian kernel of 4 mm. Each stimulus type (Partner, Countback 1, Neutral, Countback 2) was treated as a separate regressor and modeled as a boxcar function convolved with the canonical hemodynamic response function. We applied a high-pass filter with a cut-off of 128 s to remove low frequency signal components. Motion covariates were removed. Contrast images for each comparison for each participant were created and analyzed across participants using a mixed-effects general linear model, treating participants as a random effect, and conditions as a fixed effect.

All analyses were done using the Partner versus Neutral Contrast. Using a t-test in SPM2, we compared the six participants who were still together with the six who were apart at 40 months. We investigated regions that were affected during early-stage love in the Xu et al. [34] study. We applied a sphere as a region of interest (ROI) (sphere radius = 2–10 mm, $p \leq .05$, FDR corrected) to each of the areas. We also conducted an exploratory whole brain analysis ($p \leq .001$, uncorrected; ≥ 15 voxels).

For the six participants that were still together, we investigated correlations between brain activity and relationship happiness and commitment. For correlations performed on each voxel, we accepted $p < .01$ (uncorrected) for the single peak voxel in a cluster (with minimum 15 voxels). We accepted this low threshold because the areas were regions of interest, involved in the main contrast and other studies of romantic love.

Because our sample was small, we considered that our low power may lead us to miss experimental effects, particularly for the correlational analyses, and thus limit the completeness of our results. However, the standards for reaching significance with such a small group require quite substantial effect sizes, and we inspected all the correlations for outliers.

2. Results

2.1. Early-stage brain activity associated with relationship longevity

Still together > apart

There was greater activity during early-stage love in those still together after 40 months than those who were broken up in the caudate tail (Table 1), a region similar to where Xu et al. [34] found activation for the entire group in the early stage of love. Whole