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# Reduced cognitive control in passionate lovers

**Henk van Steenbergen · Sandra J. E. Langeslag · Guido P. H. Band · Bernhard Hommel**

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**Abstract** Passionate love is associated with intense changes in emotion and attention which are thought to play an important role in the early stages of romantic relationship formation. Although passionate love usually involves enhanced, near-obsessive attention to the beloved, anecdotal evidence suggest that the lover's concentration for daily tasks like study and work may actually be impaired, suggesting reduced cognitive control. Affect might also contribute to changes in cognitive control. We examined the link between passionate love and cognitive control in a sample of students who had recently become involved in a romantic relationship. Intensity of passionate love as measured by the Passionate Love Scale was shown to correlate with decreased individual efficiency in cognitive control as measured in Stroop and flanker task performance. There was no evidence that affective changes mediate this effect. This study provides the first empirical evidence that passionate love in the early stages of romantic relationship is characterized by impaired cognitive control.

**Keywords** Passionate love · Cognitive control · Flanker task · Stroop task · Passionate Love Scale (PLS)

H. van Steenbergen (✉) · G. P. H. Band · B. Hommel
Leiden Institute for Brain and Cognition, Leiden University, Wassenaarseweg 52, 2333 AK Leiden, The Netherlands
e-mail: HvanSteenbergen@fsw.leidenuniv.nl

H. van Steenbergen · G. P. H. Band · B. Hommel
Leiden University Institute of Psychology, Leiden University, Wassenaarseweg 52, 2333 AK Leiden, The Netherlands

S. J. E. Langeslag
Department of Psychology, University of Maryland, College Park, MD, USA

## Introduction

Falling in love is an experience that involves very intense affective and cognitive changes including euphoria and overwhelming joy, increased arousal and energy, emotional dependency on the partner, craving for emotional union with the beloved, and obsessional thoughts about and focused attention on the special other (Fisher 1998; Hatfield and Sprecher 1986). Several theorists have proposed that passionate love—also referred to as infatuation or limerence (Tennov 1979)—should be distinguished from another important type of love, usually referred to as companionate love (Berscheid and Walster 1978; Hatfield and Sprecher 1986; Rubin 1970 cf. Sternberg 1986). Although both types of love may often co-occur, they nevertheless show different trajectories over time (Aron and Aron 1986; Berscheid 2010; Baumeister and Bratslvasky 1999) and may serve different functions (Fisher et al. 2006; Reis and Aron 2008). Companionate love, on the one hand, has been associated with intimacy and commitment (Baumeister and Bratslvasky 1999), aspects that contribute to the maintenance of long-term relationships and allowing couples to raise their children in a safe and socially embedded environment. Passionate love, on the other hand, is thought to play a central role in forming a relationship with a partner, by becoming attracted to that individual (Reis and Aron 2008).

Although psychological studies from the last decades have substantially increased our understanding of love and its important role in human relationships (for reviews, see Berscheid 2010; Reis and Aron 2008), it is yet poorly understood how passionate love affects our cognitive functioning, in particular one's self-regulation in terms of cognitive control (also known as self-control or executive function; Baumeister et al. 2007). Research focusing on long-term relationships and companionate love has demonstrated that cognitive control indeed plays an important role in maintaining a good partnership (for an overview, see Vohs and Finkel 2006). For example, research by Pronk et al. (2010, 2011) has revealed that individual differences in the level of cognitive control predict a wide range of behaviors including being forgiving in close relationships, staying faithful in a relationship, resisting flirting behavior with a confederate, and mastering one's desire to meet an attractive person. Other studies have shown that manipulations depleting cognitive resources make lovers more interested in attractive opposite-sex others (Ritter et al. 2010) and impair constructive responses to their partner (Finkel and Campbell 2001). However, it has not yet been studied what role cognitive control plays in the earlier stages of a romantic relationship and how it might be affected by passionate love.

While it is not known yet how passionate love relates to self-control, many other changes in cognitive functioning have already been reported. For example, passionate love involves attraction and an obsession-like focus to the special other (e.g. Fisher 1998; Hatfield and Sprecher 1986). Love also accompanies huge changes in priorities and resource deployments (Reis and Aron 2008): as soon as the other becomes part of one's mental and physical life, this induces reorganizations in one's self-concept (Aron and Aron1986), overt behavior, and relationships with others (Reis and Aron 2008), which in turn increase the experience of passionate love even further (Baumeister and Bratslvasky 1999). Given these changes, it is well possible that cognitive control levels are reduced in passionate lovers. For example, taking into account the limitations to cognitive resources (Baumeister et al. 2007), it could be that the obsessive nature of passionate love imposes important constraints on performing well in tasks that require self-control. Conversely, it might also be that low control states are responsible for the intrusive thoughts and obsessive behavior characteristic for passionate love (cf. Ochsner and Gross 2005). Some authors even have interpreted such changes as cognitive impairments that passionate love may share with mental disorders like obsessive–compulsive disorder (Tallis 2005). However, until now there is only anecdotal evidence for impaired self-control in lovers.

Apart from the cognitive changes that accompany passionate love, it is also possible that motivational and affective changes (Aron et al. 2005) contribute to altered self-control. For example, states involving elevated energy levels and increased approach motivation might increase attentional focus, as has been shown by several studies using experimental manipulations of desire (Förster et al. 2009; Gable and Harmon-Jones 2010). Alternatively, it might be that increases in arousal (Dutton and Aron 1974) decrease cognitive control (Kuhbandner and Zehetleitner 2011; Pessoa 2009). Changes in affective valence have also been related to changes in cognitive control (e.g. Phillips et al. 2002; Rowe et al. 2007; but see Bruyneel et al. 2013; Martin and Kerns 2011), although a link with passionate love is not unequivocal since love usually involves both positive and negative emotions (Hatfield and Sprecher 1986).

In sum, several cognitive and affective/motivational factors might be responsible for a possible link between passionate love and cognitive control. Therefore, in the current study we investigated whether individual differences in infatuation as measured by the Passionate Love Scale (PLS; Hatfield and Sprecher 1986) are associated with differences in cognitive control as measured in a standard laboratory task. The PLS was used because this questionnaire is specially designed to assess passionate love. This unidimensional scale comprises the cognitive (e.g. intrusive thinking; preoccupation), emotional (e.g. attraction, desire for complete and permanent union, and physiological arousal), and behavioral components (e.g. service to the other, maintaining physical closeness) of passionate love. Given that feelings of passionate love tends to decline quite rapidly over time (Berscheid 2010; Sprecher and Regan 1998), we restricted our sample to participants who fell in love no longer than 6 months ago. Self-reported affective valence and arousal as measured by the affect grid (Russell et al. 1989) was used to test for potential affective mediation. Inspired by a neuroimaging study showing that PLS scores are correlated with increased reward processing when participants view pictures of their beloved (Aron et al. 2005), intense feelings of passionate ove were induced before self-reported affect and cognitive control were assessed.

In order to investigate the possibility of potential moderating effects, the experimental design included two additional factors: Task Type and Participant's Sex. Concerning Task Type, two different tasks were used to measure cognitive control: a flanker task (Eriksen and Eriksen 1974) and a Stroop task (Stroop 1992). These two classic tasks assess the individual ability to attend to relevant information while filtering out distracting, irrelevant spatial and semantic information, respectively. Both tasks thus require cognitive control to successfully ignore the distracting information introduced by these tasks. Previous studies have already shown that affective states can modulate both Stroop (Phillips et al. 2002) and flanker performance (Rowe et al. 2007; but see Bruyneel et al. 2013; Martin and Kerns 2011), although this modulation might involve different mechanisms. As has been argued in detail elsewhere (Martin and Kerns 2011), effects on a Stroop task may reflect response inhibition modulation whereas effects on the flanker task might reflect a modulation of the visuo-spatial focus of attention. Thus, the Task Type manipulation allowed us to test whether a possible link between passionate love and cognitive control generalizes across the spatial and verbal domain—indicating a general change in control—or whether it is domain-specific—possibly indicating different mechanisms.

Second, we included the factor Participant's Sex because previous studies have shown that male and female lovers differ in various ways. For example, sex differences have been reported for the experience and appreciation of passionate love (Rubin et al. 1981), levels of sexual desire (Baumeister et al. 2001), and cognitive impairments following mixed-sex interactions (Karremans et al. 2009). Because any of these differences could potentially moderate the link between passionate love and cognitive control, our design therefore included a balanced number of male and female participants in order to test for potential differences related to participant's sex.

## Method

### Participants

Fifty-one heterosexual students who had recently (at most 6 months ago) fallen in love participated either for payment or course credits. Based on initial screening of the behavioral data, eight participants were excluded from further analyses because of chance performance (about 50 % correct, i.e., they responded to the distractor rather than to the target) in at least one of the experimental task blocks.[1] The age range of the remaining 43 participants (23 females; 20 males) was 18–27 years (mean = 20.9 years), four participants were left-handed. All participants had a relationship with their beloved (mean duration = 2.8 months). The reported duration of being in love ranged between 1 and 6 months (mean = 3.4 months). All participants were Dutch native speakers, not color blind, and without a psychiatric history.

### Tasks

Two variants of a classic cognitive control paradigm were presented in different blocks of trials. The flanker task (Eriksen and Eriksen 1974) consisted of centrally presented target stimuli which were vertically flanked on either side by two identical response-compatible or response-incompatible stimuli. The Stroop task (Stroop 1992) consisted of a column of five identical stimuli presented in response-compatible or response-incompatible ink colors. Flanker and Stroop stimuli were carefully matched by using two non-overlapping sets of Dutch color words ("brown", "gray", "yellow", and "red" or "purple", "green", "orange", and "blue"). Using words in both tasks allowed us to match the imperative stimuli as closely as possible, whereas the source of the response interference is different (spatial for the flanker task, semantic for the Stroop task). Each task used a counterbalanced unique set of four words. Two targets were mapped to a left hand response, whereas the other two targets were mapped to a right hand response.

E-prime® software was used for stimulus presentation and response recording. All trials started with a fixation cross (randomly varying intervals of 800, 1,000, or 1,100 ms), followed by the stimulus, which was presented until response registration or, in the case of omission, for 1,500 ms. In half of the trials the stimuli would call for different responses (incompatible condition; e.g. the word "green" surrounded by the words "yellow" in the flanker task and the word "blue" printed in red in the Stroop task) whereas in the other half identical target and distracter dimensions would call for the same response (compatible condition; e.g. the word "green" surrounded by the words "green" in the flanker task and the words "blue" printed in blue in the Stroop task). All trials were presented in an unconstrained random sequence. Stimuli appeared in lowercase in Arial bold font (the arrow of words being 3.5 cm wide and 5.4 cm high) and were presented on a grey background. Flanker-task stimuli used black ink color. Participants viewed the stimuli on a 17″ monitor from about 60 cm.

### Procedure

After giving informed consent, participants received task instructions that emphasized both speed and accuracy. Both the flanker and the Stroop task were practiced in separate blocks of 16 trials that included performance feedback. Participants then filled out a Dutch translation of the PLS (a unidimensional scale that includes 30 items on a 9-points scale; Hatfield and Sprecher 1986; Langeslag et al. 2007) and were instructed to intensify an amorous mood by imagining and writing about an appropriate romantic event from their past or by focussing on a romantic vignette they were given. During this 10-min affect induction period, participants listened via headphones to their own favorite love-related music which they had brought with them. This procedure is known to evoke intense feelings of romantic love (Mashek et al. 2000). Participants then performed a block of 72 trials for each task separately. After a 3-min affect induction repetition, the same two blocks were presented again. The order of tasks was counterbalanced across participants. Participants rated their current affective state using a computerized affect grid (measuring affective valence and arousal; Russell et al. 1989) occasionally provided throughout the experiment.

[1] Including these participants in the analysis did not affect the main findings reported below.

## Results

Measures of interference (i.e., the "Stroop effect" and the "flanker effect") for correct reaction time (RT) and accuracy were calculated for both tasks by subtracting average performance on compatible trials from average performance on incompatible trials. Both tasks produced robust RT interference scores (flanker task: 29 ms, $t(42) = 8.17$, $p < .001$; Stroop task: 38 ms, $t(42) = 5.24$, $p < .001$), indicating that they successfully induced interference. There was no evidence that the RT interference scores were correlated ($r = -.071$, $p = .651$).

Interference scores were subsequently analyzed using a General Linear Model (GLM) analysis in SPSS with the variables PLS score (the between-subjects continuous predictor; in SPSS the "covariate" used as variable of primary interest, cf. Wildt and Ahtola 1978, p. 52), Task Type (within subjects: flanker vs Stroop), Participant's Sex (between subjects: female vs male) and their interactions as predictors.

The GLM analysis indicated that PLS scores significantly predict variation in the interference effect ($F(1,39) = 5.18$, $p = .028$, MSE = 974.54, partial eta squared = .117). This effect was independent of Task Type ($F(1,39) = 1.252$, $p = .270$, MSE = 1,263.70, partial eta squared = .031) and Participant's Sex ($F(1,39) = .147$, $p = .704$, MSE = 974.54, partial eta squared = .004). As is illustrated in Fig. 1, higher PLS scores were associated with increases in the interference effect (pooled over tasks). Main effects of Task Type and Participant's Sex or higher-order interactions were not observed either ($Fs < 1.44$). A predictive effect for PLS score was not found for interference effects measured in accuracy ($F(1,39) = .26$, $p = .611$, MSE = .004, partial eta squared = .007), indicating that the RT results could not be accounted for by a speed-accuracy trade off. A separate analysis on overall RT showed that the effect of PLS on attentional interference could not be accounted for by a scaling effect due to RT slowing ($F(1,39) = 1.25$, $p = .270$).

We re-ran analyses to ensure that the effects on interference were not exclusively driven by three particular PLS items that explicitly refer to obsessive thoughts and intrusive thinking (i.e., items 5, 19, and 21). A PLS sum score that did not include these items, was also shown to be a reliable predictor of interference effect increases ($F(1,39) = 5.22$, $p = .028$, MSE = 972.63, partial eta squared = .118).

To test for possible affective mediation, we checked whether the effect of PLS on interference might have been related to self-reported affect. In order to get an estimate of the participant's affective state at the moment they performed the cognitive-control tasks, we analyzed average arousal and valence ratings (9-points scale) across the four ratings that were provided just before and after the completion of the task blocks. Arousal was positively associated with PLS scores ($r = .326$, $p = .033$), whereas valence was not related to PLS ($r = .019$, $p = .902$). This shows that only arousal shares some variance with PLS scores. But in order to be a candidate for mediation, variations in this variable must also significantly account for variations in the dependent variable (Baron and Kenny 1986). However, this correlation was not found in the present dataset: arousal—interference, $r = .185$, $p = .235$; valence—interference, $r = -.134$, $p = .393$. Thus, neither mood valence nor arousal could have played a reliable mediating role in the relation between passionate love and cognitive control.

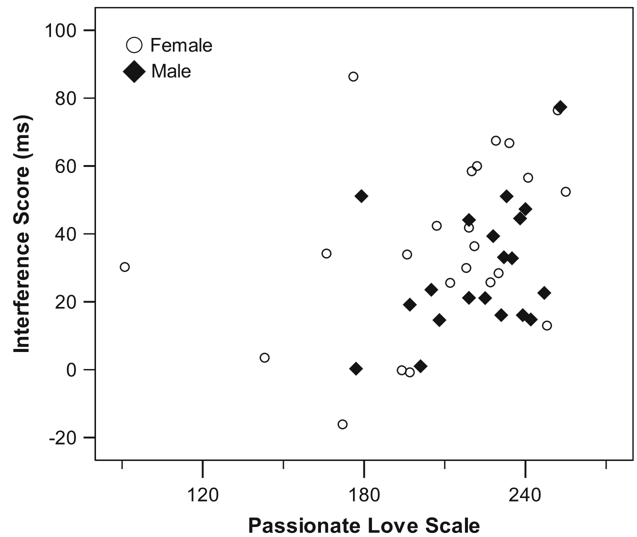


**Fig. 1** Positive correlation between Passionate Love Scale score and interference score. Given that the GLM showed that this effect was independent of Task Type, a composite score of individual interference effects averaged across the Stroop and flanker tasks was plotted

## Discussion

This study provides the first evidence for an association between passionate love as measured by the PLS and reduced cognitive control as measured by standard laboratory tasks (Stroop and flanker task) in a sample of students in the early stage of a romantic relationship. There was no evidence for an affective mediation of this effect. Furthermore, the effect did not interact with the specific task employed, suggesting that intense passionate love is associated with reduced cognitive control in multiple ways. The link between passionate love and control was also not moderated by participant's sex.

Which explanation might best account for the findings we obtained? As mentioned in the introduction, both cognitive and affective aspects of passionate love could be associated with reduced cognitive control. However, we failed to find evidence for a strong affective mediation: neither arousal nor valence was found to predict cognitive control impairment, even though arousal was positively related to passionate love. Although this null-finding does not allow strong inferences, it is thus possible that the effect we obtained rather reflects changes in the cognitive system.

Our finding provides an important extension to earlier work about self-control and relationships. The observations of reduced control in passionate lovers contrasts with earlier studies demonstrating that increased self-control is important for maintaining long-term relationships (Finkel and Campbell 2001; Pronk et al. 2010, 2011; Ritter et al. 2010; Vohs and Finkel 2006). Accordingly, it might be speculated that forming and maintaining a relationship requires different control settings. In other words, it could be that in the early stage of forming a relationship reduced self-control might have beneficial effects, e.g. it may expand the self-concept which allows incorporating the other in one's cognitive system (Aron and Aron 1986). In the long-term, however, self-control may need to set in to shield and protect the new relationship against potential threats (e.g. Pronk et al. 2010).

Reduced cognitive control might also account for modulations in impulsivity typically associated with passionate love (Malladian and Davies 1994; Sophia et al. 2009). Dual-process models have suggested that disrupted top-down cognitive control might increase impulsive action (e.g. Baumeister et al. 2007; Hofmann et al. 2009), for example in addiction (Dalley et al. 2011; Wiers et al. 2013). Indeed, some authors have drawn parallels between addiction and passionate love suggesting that shared brain processes drive such impulsivity (Burkett and Young 2012). Interestingly, it has also been shown that—like impaired cognitive control (Pronk et al. 2010, 2011)—increased impulsivity predicts engaging in unfaithful activities while dating (McAlister et al. 2005). Nevertheless, future research is needed to illuminate the causal relations that might underlie these associations between self-control, impulsivity and passionate love.

Although our findings of reduced control might be interpreted as an impairment in cognitive functioning (cf. Tallis 2005), it is important to emphasize that a lack of cognitive control is not necessarily detrimental to all aspects of behavior. For example, it has been suggested that low control states facilitate divergent thinking and creativity (Friedman and Förster 2008; Hommel 2012). From an evolutionary perspective it has been argued that creative acts might be highly valuable in forming a relationship because they attract the attention of a romantic partner and facilitate mating behavior (Miller 2000). Indeed, studies that have asked participants to imagine romantic scenarios have provided evidence for improved creativity and reduced analytic thinking (Förster et al. 2009; Griskevicius et al. 2006). However, research will have to confirm whether passionate love during actual courtship is also related to creativity.

Another important issue that warrants further investigation is the association between sexual desire and cognitive control. Although some researchers have claimed that sexual desire and passionate love are distinguishable because they involve different emotion systems that serve different functions (Diamond 2004; Gonzaga et al. 2006), passionate love and sexual desire typically tend to co-occur (Berscheid and Walster 1978; Cacioppo and Hatfield 2013). Indeed, PLS scores have been found to correlate modestly with self-reported desire for sexual/physical intimacy (Hatfield and Sprecher 1986) and the frequency of sexual behavior (Aron and Henkemeyer 1995). Nevertheless, it is unlikely that the negative association between passionate love and cognitive control in our study is driven by differences in sexual desire. For example, in a first attempt to dissociate effects of passionate love and sexual desire, Förster and colleagues have shown that love- versus sex-related stimuli prime opposing effects on control-related functions, with love decreasing and sex increasing local processing and analytic thinking (Förster et al. 2009). Thus, if anything, the effects of sexual desire on control might have counteracted the negative correlation we observed. In addition, men and women usually differ in their sexual desire (Baumeister et al. 2001), whereas we did not find any evidence for gender effects in our study.

Future work is also required to understand how the reduced cognitive control we observed is driven by neuromodulatory effects in the brain. Cumulating neuroscientific evidence has suggested that passionate love, companionate love, and lust involve different neurochemical systems and hormones (Cacioppo and Hatfield 2013; Fisher 1998; Reis and Aron 2008). With respect to passionate love, it has been hypothesized that elevated catecholamines, such as dopamine, play a central role in animal and human courtship attraction. Indeed, dopamine has been shown to modulate mating preference in animals (Fisher et al. 2006), and neuroimaging studies on passionate love in humans have consistently found activity in the mesolimbic dopaminergic reward system including the striatum (Aron et al. 2005; Bartels and Zeki 2000; Langeslag et al. 2012). Moreover, PLS scores correlate positively with activity in this region (Aron et al. 2005). It is possible that such dopaminergic modulation changed the balance between striatal and prefrontal processing, which might have driven the changes in cognitive control we have observed (cf. Cools 2008).

One limitation of the current research is that we restricted our sample to participants who fell in love only recently (at most 6 months ago). In addition, the cognitive control measurement was preceded by an affect induction procedure that involves increasing passionate love. Both aspects of this study might have inflated the negative association we have observed between passionate love and cognitive control. For example, passionate love usually peaks in the early stage of a romantic relationship, and low levels of passionate love are likely not to impair self-control. In addition, as discussed earlier, in order to maintain a long-term relationship self-control is likely to become increased over time. It is also possible that the affect induction method increased obsessive thoughts about and affective responses to one's imagined partner, which might have contributed to the effect observed. Note however that our data did not suggest affective modulation, and the effect was also found in the analysis that corrected for PLS items related to obsessive thinking.

As is inherent to all studies adopting a correlational approach, we cannot determine whether passionate love is the cause or the effect of impaired control, or whether both are two different expressions of the same underlying "syndrome". Given well-known reciprocal interactions between affective processes and control processes acting even at very short time scales (Ochsner and Gross 2005; Cohen et al. 2011), it is unlikely that such interactions can be unraveled easily. It is also possible that part of the cognitive control state measured in this study reflects a more stable trait-like measure of self-control. Given that we did not measure levels of trait self-control, we cannot exclude the possibility that participants reporting high levels of passionate love were already low in self-control in the first place. However, a re-analysis of findings from a recent study that includes individual scores of self-control and aspects of passionate love measured by the Love Attitude Scale (subscales Eros and Mania) in a university sample of romantic partners (cf. Vohs et al. 2011) did not reveal such correlations (Vohs and Finkenauer, personal communication, July 19, 2012). Obviously, it is still possible that trait self-control may predict passionate love in a sample of people who have recently fallen in love.

To conclude, our study is the first to show that high levels of passionate love of individuals in the early stage of a romantic relationship are associated with reduced cognitive control. Anecdotal evidence for effects of that sort have long been reported (cf. Tallis 2005) but were—to the best of our knowledge—never investigated before. Extending earlier research showing the importance of cognitive control for the maintenance of long-term relationships, our findings suggest that reduced cognitive control is an important aspect of passionate love and the initial stage of a romantic relationship. These findings encourage future studies to study the neural mechanism of this effect and the implications of this low control state for other cognitive functions.

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