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Updating Inferences About Negative Events: Does the Direction of the Update Matter?

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Abstract

Belief updating—the revision of beliefs in light of new evidence—is central to adaptive cognition and emotion regulation yet often disrupted in emotional disorders. This study examines the overlooked process of internally driven inferential update, the capacity to move spontaneously between competing causal explanations for an event regardless of new information. We address two gaps in literature: whether benefits depend on shift direction or on shifting itself, and whether effects persist to the next day. In two studies we tested inference updating for participants' personally meaningful negative events. On Day 1 they were assigned to one of three conditions: shifting from depressogenic-to-benign inferences, the reverse shift, or a no-shift control condition. Outcomes were assessed immediately after the manipulation and 24 hours later. We tested whether change in symptoms depended on shift direction or on the mere flexibility of shifting across inferences, regardless of direction. We further tested whether trait brooding was associated with the effects of shifting. Across studies, immediate benefits—improved mood and reduced state rumination—were specific to the depressogenic-to-benign condition. On Day 2, Study 1 showed that only the depressogenic-to-benign shift increased benign inferences, whereas Study 2 found that both shift directions did so relative to the no-shift condition. Trait brooding affected emotional reactivity and next-day inferences but did not interact with condition. These findings suggest that internally driven inferential shifts are a viable form of belief updating about emotionally-laden events and highlight the clinical utility of inferential flexibility for addressing maladaptive cognitive and emotional processes.

Keywords: belief updating, negative inferential style, inferential flexibility, negative mood, brooding.

Updating Inferences About Negative Events: Does the Direction of the Update Matter?

Belief updating refers to the cognitive process by which people revise existing beliefs or expectations when confronted with contradictory facts or information (Sharot & Garrett, 2016; Kube et al., 2020). It is a core mechanism underpinning adaptive cognition, learning, decision-making, and emotional regulation (Friston, 2005; Kube et al., 2020).

The assumption that beliefs can be corrected by providing new facts—the information deficit model—has been challenged, as misinformation often persists despite corrections (Ecker et al., 2022). This persistence is partly driven by memory processes: original beliefs compete with new information, particularly when they are more salient or deeply encoded (Kemp et al., 2024). Even after change, people may revert to prior beliefs because of memory biases and emotional salience, a phenomenon known as belief regression (Swire-Thompson et al., 2021; Swire-Thompson et al., 2023). These challenges are especially pronounced in clinical contexts, where individuals with emotional disorders, such as depression, often hold entrenched negative beliefs about themselves, others, and the future (Kube & Rozenkrantz, 2021). Such beliefs are typically encoded with strong affective salience, making them highly accessible and resistant to change (Kirchner et al., 2023; Spaeth et al., 2024). This persistence underscores the limits of belief updating approaches that depend primarily on external correction.

Belief change, however, can also arise endogenously, without new external information. In such cases, individuals revise their understanding of events through spontaneous causal inferences, impressions, or interpretations (Andrews-Hanna et al., 2014; Kelley, 1973; Malle, 2004; Ramey et al., 2024). These are constructed from existing knowledge and memory (Fernbach et al., 2010; Lombrozo, 2016; Friston, 2010) and are highly malleable, context-sensitive, and shaped by framing, emotional states, and motivational goals (Marigold et al., 2007; Hu et al., 2015). This gap in traditional belief updating models has led to an interest in endogenous processes that do not require new external information. Importantly, these endogenous processes draw on the flexible recombination of stored knowledge, memories, and associations (Gawronski & Bodenhausen, 2011; Johnson-Laird, 2010). Through this recombination, reflection on past events can trigger retrieval of relevant episodic and semantic details, which are integrated via associative, causal, and logical reasoning (Barry et al., 2019; Kube & Rozenkrantz, 2021; Hertel et al., 2023; Wellons & Wahlheim, 2025). In turn, executive functions—particularly cognitive control and flexibility—support the generation of alternative interpretations (Demetriou et al., 2024; Makris et al., 2017), while affect and motivational goals guide attention toward emotionally coherent or self-relevant details (Priniski et al., 2024; Friston, 2010; Spencer & Rerup, 2024). Taken together, through iterative internal evaluation, these recombined representations can produce psychologically meaningful and adaptive belief change.

Inference-making serves important functional roles, including helping people derive meaning (Frödin, 2025), regulate emotion (Ong et al., 2019), and guide behavior in emotionally salient contexts (Bartolo & Averbeck, 2021). Yet not all inferences are adaptive. According to the hopelessness theory, depressogenic inferences—attributing events to internal, stable, and global causes while predicting negative consequences and diminished self-worth—contrast with benign inferences, which involve external, transient, and specific causes (Abramson et al., 1989; Hu et al., 2015). Consistently drawing depressogenic inferences reflects an inferential style that is a well-established vulnerability factor for depression (Alloy et al., 1992; Sanjuán et al., 2008). However, inferential styles vary significantly across the general population and clinical groups (e.g. Schulze et al., 2024).

Inferential style was historically considered a stable trait (Alloy et al., 2006; Burns & Seligman, 1989), but recent evidence shows it is flexible (Bernstein et al., 2019). People may generate depressogenic inferences in some situations and benign ones in others (Fresco et al., 2006), and lower variability in these patterns predicts greater depression risk (Moore & Fresco, 2007). Our work has focused on a specific form of this flexibility—inferential shift, referring to revising one's inferences for the same event from a depressogenic to a benign explanation. Whereas inferential flexibility denotes the capacity to internally generate alternative causal explanations, an inferential shift denotes the actual change. To examine the cognitive and emotional consequences of such shifts, we developed the Inferential Shift of a Personal Event (ISPE; Perlman & Mor, 2022; Perlman et al., 2024), a task designed to quantify inferential shifts and assess their immediate as well as delayed effects.

In the ISPE, participants imagine a personally meaningful negative event (e.g., "I will not do well on my finals"), generate a depressogenic causal inference ("I don't know how to study well"), then rethink the event and generate a benign inference ("many students do not know how to study for their first-year exams"). In some versions, participants produce a second uninstructed inference, which allows us to measure the degree to which it represents a spontaneous shift. After each inference, participants rate the degree to which it reflected an internal, global, and stable attribution, as well as their current mood and state rumination. Because ruminative thinking—rigid, repetitive negative thinking that amplifies depressogenic inferences—is a known risk factor for depression (Pössel & Pittard, 2019; Pössel & Winkeljohn Black, 2017), we also examined state and trait rumination. Across three studies (Perlman et al., 2024), instructing participants to shift from depressogenic to benign inferences improved mood and reduced rumination relative to a no-shift control, with some benefits lasting into the next day. However, these enduring effects were not observed among high brooders, who also shifted less spontaneously. Together, these findings underscore the mood- and rumination-related benefits of internally generated shifts, highlight trait brooding as a limiting factor. However, they leave a gap—it is unclear whether these benefits reflect general flexibility or the specific advantage of shifting away from depressogenic inferences, and whether such effects extend in the reverse direction and persist over time—questions that motivated the current research.

In the current research, we investigate whether positive emotional outcomes are driven by the *direction* of inferential shifts (i.e., from depressogenic to benign) or by *general inferential flexibility*, regardless of direction. Direction-specific effects parallel findings in belief updating, where people show valence-dependent asymmetries: they are more likely to adopt a belief they once rejected than to abandon one they once accepted, and they update more readily from good than bad news—a pattern known as the optimism bias (Yang et al., 2022; Sharot et al., 2011; Garrett & Sharot, 2017). These asymmetries reflect not only cognitive processes but also motivational ones, as individuals selectively integrate information consistent with desired beliefs or self-concept (Drobner & Goerg, 2024). By contrast, inferential flexibility reflects a valence-independent willingness to revise inferences, associated with open-minded thinking (Baron, 2019), perspective-taking (Stanovich & West, 2007), and low need for cognitive closure (Kruglanski & Webster, 1996). Flexibility also requires effortful reconsideration and restructuring of inferences, weighing potential accuracy gains against the mental effort involved (Bruckner et al., 2025). Evidence from belief updating research indicates that flexible updating in both directions can confer cognitive and emotional benefits (Everaert et al., 2021). However, it is unclear whether similar emotional and cognitive benefits of inferential change would be explained primarily by the direction of the shift or by the exercise of flexibility itself. We elucidate this issue in the current research.

In this study, the ISPE serves both as the manipulation and as the basis for assessing longer-term inferential change. On Day 1, participants are randomly assigned to one of three conditions and *instructed* to generate two consecutive inferences about their self-relevant negative future event—either shifting from depressogenic to benign, from benign to depressogenic, or making no instructed shift. On Day 2, they are asked to generate a *spontaneous,* uninstructed, causal inference for the same event. This delayed, unguided response indexes the extent to which the Day 1 inferential change (or lack of, in the control condition) was integrated and retained, capturing memory-based, internally driven change rather than a reaction to new evidence. By focusing on this delayed uninstructed spontaneous inference, our approach emphasizes retrieval and integration as key processes in enduring belief change (Ecker et al., 2022; Swire-Thompson et al., 2023). This approach parallels delayed-retrieval paradigms used to examine the persistence of cognitive reappraisal effects (Kross & Ayduk, 2017), the consolidation of attitude change (Petty & Briñol, 2020), and the internalization of inferential shifts (Perlman et al., 2021). Isolating this spontaneous response offers a sensitive test of whether a brief, *instructed* cognitive shift can translate into lasting changes in how events are perceived.

Building on the theoretical framework of belief updating and inferential flexibility outlined earlier, and to address gaps in prior research concerning differential effects of shift direction versus flexibility and next-day effects, we formed two main predictions: (1) Participants in either shift conditions (depressogenic-to-benign or benign-to-depressogenic) would report greater improved mood and reduced state rumination immediately after the second inference (end of ISPE) compared to those in the no-shift condition. We expected greater benefits in the depressogenic-to-benign condition due to the stronger emotional impact of a final shift toward positivity. (2) On the following day, participants in the two shift conditions (combined) would show lower inference depressive bias than those in the no-shift condition, with the depressogenic-to-benign condition again expected to show the lowest inference depressive bias, reflecting the sustained influence of a more adaptive inferential shifting. Given our previous findings pertaining to trait brooding, we also explored whether brooding moderates the effects of inferential shifts on negative mood, state rumination, and next-day inference negativity. Specifically, we predicted that higher brooding levels would attenuate the emotional and cognitive benefits of shifting from depressogenic to benign inferences and hinder the maintenance of adaptive shifts over time. To test these predictions, we conducted two online studies: a non-preregistered initial investigation (study 1) and a subsequent preregistered replication (study 2), designed to increase the robustness and transparency of the findings.

Transparency and Openness

Preregistration

Study 1 was not pre-registered. Study 2 was pre-registered on As.Predicted prior to data collection. The preregistration, including hypotheses, design and analysis plan, is available at [https://aspredicted.org/x4p6-y5f8.pdf].

Data, materials, code, and online resources

The data and code supporting the findings of this study are publicly available on the Open Science Framework (OSF) and can be accessed at https://osf.io/9yx7c/. The materials used in this study are not publicly available due to their proprietary nature. Researchers interested in accessing the materials for research purposes may contact the corresponding author.

All supplemental material related to this study will be posted on the journal's website.

Reporting

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

Ethical approval

This study was conducted in accordance with the ethical standards of the Hebrew University of Jerusalem's ethics committee. The approved protocol number is IRB_2025_096.

Study 1

Method

Participants

The sample size was based on a G*Power analysis using the most stringent statistical test we performed (see analytic plan). The analysis indicated that a sample of 158 participants would provide 80% power ($1–\beta = 0.80$) to detect a medium effect size ($f = 0.25$), assuming an alpha level of .05. This effect size was selected based on previous findings from a closely related experimental paradigm (Perlman et al., 2024). Therefore, 162 undergraduate students ($M_{age} = 22.77$, $SD = 3.32$, 130 females, 32 males) from the Hebrew University of Jerusalem were recruited for the study through the university's online experiment management system, SONA, in return for course credit or payment. Participants were compensated for each session separately. To be eligible, participants had to be over 18 years old and proficient in Hebrew. Seven participants were excluded from the study either because they did not complete the first experimental session or they did not follow task instructions correctly (e.g., they reported an event that did not happen to them instead of describing a personal one, as instructed), and 15 more dropped out before completing the second session (8 from the depressogenic-to-benign, 6 from the benign-to-depressogenic and 1 from the no-shift condition). They were removed from the analyses pertaining to this session only. Thus, the final sample included 155 participants in the analyses pertaining to the first session (130 women, 25 men) and 140 participants (117 women, 23 men) in the analyses pertaining to the second session.

Materials

Inferential Shift of a Personal-Event (ISPE) Assessment Procedure. We used the Inferential Shift of a Personal-Event (ISPE; Perlman & Mor, 2022; Perlman et al., 2024) procedure to assess participants' inferential shift in response to a self-relevant feared future negative event. The ISPE consists of three phases:

Event description. Participants described a personal negative event they feared might happen to them in the future. They were instructed to write vividly about this event and in the present tense as though it were unfolding like a movie scene.

First inference. Participants generated a cause for the event and completed state measures of inference depressive bias, mood and rumination (see measures below). The nature of the cause was guided by condition: participants in the depressogenic-to-benign and the no-shift conditions were instructed to generate a depressogenic inference (global, stable, internal) causal inference (e.g. "try to think of a cause that will probably lead to similar events in the future, and have similar effects on other areas of your life"). In contrast, those in the benign-to-depressogenic condition generated a benign inference (specific, transient, external; e.g.: "focus on a cause that is tied to contextual and external circumstances. Identify a factor that could cause the specific event you described, but is unlikely to recur in the future or to affect other aspects of your life").

Second inference. Again, participants generated a cause for the event per condition, and completed state measures of inference depressive bias, mood and rumination (see measures below). Those in the depressogenic-to-benign condition were instructed to make a benign inference, whereas those in benign-to-depressogenic and in the no-shift condition were instructed to make a depressogenic inference (for experimental instructions see Appendix A).

Self-Report Measures

State Measures[1]

Inference Depressive Bias was assessed using a state version of the Cognitive Style Questionnaire (CSQ; Alloy et al., 2006). The original CSQ is a well-validated trait measure

[1] All state measures, in both studies, were administered at multiple time points. Where reliability was stable across time, a single reliability coefficient is reported; where it varied, a range is provided to reflect the variation across administrations.

designed to assess cognitive vulnerability to depression. In the state version, participants write a cause for a personal negative event (see above) and respond to six items assessing the perceived internality, stability, and globality of the cause using a Visual Analogue Scale (VAS) ranging from 0 (*not at all*) to 100 (*extremely*). Reliability of the state CSQ was moderate in past research (α=0.63; e.g., Peters et al., 2011) and good in the current sample (α=0.77, 0.82 in the two measurement points respectively).

State Mood was measured using six items from the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988): three negative (sad, blue, downhearted) and three positive (happy, cheerful, joyful). These items have been used in prior research (e.g., Batcho, 2020; Batcho & Shikh, 2016; Ganor et al., 2022) with reliability estimates comparable to the full PANAS (e.g., α = .88 for Positive Affect; α = .87 for Negative Affect; Watson et al., 1988). Participants indicated the extent to which they currently experienced each emotion using a VAS ranging from 0 (not at all) to 100 (extremely). Factor analysis indicated that the positive and negative items loaded strongly and in opposite directions on a single underlying factor. Accordingly, positive items were reverse scored and combined with negative items into a single composite, such that higher scores reflected greater negative mood. Reliability in the current sample was excellent (α = .91).

The Brief State Rumination Inventory (BSRI; Marchetti et al., 2018) was used to assess state rumination. It includes eight statements, rated on a VAS ranging from 0 (completely disagree) to 100 (completely agree), with higher mean scores indicating higher levels of state rumination. The BSRI was reported to have excellent reliability in its original validation (α=0.92–0.95; Marchetti et al., 2018), and has shown very good reliability in the current sample (α=0.86-0.92 across measurement points).

Trait Measures [2]

Trait brooding was measured using the brooding subscale of the **Ruminative Response Scale - Short Form (RRS-SF; Treynor, Gonzalez, & Nolen-Hoeksema, 2003).** The RRS-SF is a 10-item scale that assesses, reflection and brooding (5 items each). Items are rated on a 4-point Likert scale, ranging from 1 (almost never) to 4 (almost always). The original scale has demonstrated good reliability (α=0.77 for brooding; Treynor et al., 2003), and reliability was comparable in the current sample (α=0.79).

Procedure

The experiment was conducted online in two sessions (one day apart) using Qualtrics. In the first session (see Figure 1), participants provided demographic information and completed trait measures. Then, they were randomly assigned to complete the ISPE in one of three experimental conditions (depressogenic-to-benign, benign-to-depressogenic, no-shift). Twenty-four hours later, they received a link to the second session, in which they were presented with the negative event they had previously written and were asked to write an open causal inference for the event (they were told that the inference could be the same as one of the inferences they wrote previously or a new one). Finally, participants wrote about a positive personal event to counter any negative feelings.

Analytic Plan

The same analytic approach was used in both studies. As a manipulation check (see Figures 2a and 3a), inference depressive bias scores were submitted to a repeated-measures ANCOVA with condition (depressogenic-to-benign, benign-to-depressogenic, no-shift) as a between-subjects factor, time (first inference, second inference) as a within-subjects factor, and standardized brooding scores as a covariate.

[2] In addition to the trait measurements mentioned, the Cognitive Style Questionnaire – Very Short Form (CSQ-VSF; Huys et al., 2016) and the Patient Health Questionnaire (PHQ-8; Kroenke et al., 2001) were administered for exploratory purposes, and will not be described further.

Our first hypothesis concerned the temporal dynamics of inferential change, specifically whether participants' responses to the initial inference differed from their responses to the shift manipulation. We first conducted an omnibus test to assess for any differences across time and conditions. We report significant interactions obtained on the omnibus tests and perform follow-up contrasts for interpretation. Because the theoretical processes underlying the initial inference and the subsequent shift may differ, and in line with prior research that has adopted this disaggregated approach (e.g., Askim & Knardahl, 2021; Yovel et al., 2014), we followed up significant interactions in the omnibus test by examining these phases separately. Accordingly, negative mood (Figures 2b and 3b) and state rumination (Figures 2c and 3c) were each analyzed in two repeated-measures ANCOVAs with condition as a between-subjects factor and brooding as a covariate: one testing changes from baseline to immediately after the first inference, and another testing changes across the two inference tasks.

The second hypothesis addressed whether these effects extended beyond the experimental session. To this end, next-day inference depressive bias (Figures 2d and 3d) was analyzed using an ANCOVA with condition as a between-subjects factor and brooding as a covariate.

Finally, because trait brooding has been shown to affect inferential shifts (Perlman et al., 2024), we explored its potential moderating role, and included it as a covariate in all primary analyses to account for its main effect. Moderation was examined through condition by brooding interactions. All findings regarding brooding moderation are reported in the Supplementary Materials.

Results

The Effect of Condition on Inferential Shifting (Manipulation Check)

The main effects of time, $F(1,149) = 7.35$, $p = .008$, $\eta_p^2 = .05$, and condition, $F(2,149) = 17.01$, $p < .001$, $\eta_p^2 = .19$, were both significant. As predicted, these effects were qualified by a significant time by condition interaction, $F(2,197) = 105.04$, $p < .001$, $\eta_p^2 = .52$, suggesting that changes in inference depressive bias across time differed substantially by condition.

Follow up pairwise contrasts with Bonferroni correction revealed that, as expected, inference depressive bias significantly decreased from the first to the second inference in the depressogenic-to-benign condition ($p < .001$, 95% CI [19.40, 29.07], $d = 1.87$[3]), increased in the benign-to-depressogenic condition ($p < .001$, 95% CI [-22.45, -12.22], $d = -1.34$), and did not change in the no-shift condition ($p = .056$, 95% CI [-0.14, 10.76], $d = 0.41$; see Table 1).

Effects of Condition on State Measures (Hypothesis 1)

The Effects of Condition and Time on Negative Mood and State Rumination

The omnibus ANOVA predicting negative mood, revealed a significant interaction between time (across the three time points) and condition, $F(4, 302) = 2.86$, $p = .024$, $\eta_p^2 = .036$, demonstrating that changes in negative mood over time varied by condition. Similarly, predicting state rumination, the interaction between time (across three time points) and condition was also significant, $F(4, 298) = 10.03$, $p < .001$, $\eta_p^2 = .119$, demonstrating that changes in state rumination over time varied by condition. To follow up these significant interactions, we examined each experimental phase separately.

The Effect of the First Inference on Negative Mood and State Rumination

The main effect of time on negative mood was significant, $F(1,149) = 73.15$, $p < .001$, $\eta_p^2 = .33$, indicating a significant increase in negative mood across conditions from baseline to following the first inference. Neither the main effect of condition, $F(2,149) =$

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[3] For the calculation of Cohen's d, we used the adjusted group means (EMMeans) and divided the mean difference by the square root of the mean square error (√MSE), which represents the standard deviation after controlling for covariates. The use of √MSE provides an accurate effect size measure that accounts for the influence of the covariates.

0.52, p = .595, η_p^2 < .01, nor the time by condition interaction, F(2,149) = .96, p = .387, η_p^2 =.01, was statistically significant, suggesting that the increase in negative mood was consistent across conditions following the first inference.

The main effect of time on state rumination was also significant, F(1,149) = 57.33, p < .001, η_p^2 = .28, indicating a significant increase in state rumination across conditions from baseline to following the first inference. Neither the main effect of condition, F(2,149) = 0.03, p =.97, η_p^2 = .00, nor the time by condition interaction, F(2,149) = 1.89, p =.15, η_p^2 = .02, was statistically significant. Thus, the increase in state rumination was consistent across conditions following the first inference.

The Effect of the Second Inference on Negative Mood and State Rumination

The main effects of time, F(1,149) = 1.71, p = . 193, η_p^2 = .01 and of condition on negative mood were not statistically significant, F(2,149) = 1.32, p = .269, η_p^2 = .87. However, as predicted, the time by condition interaction was significant, F(2,149) = 11.22, p < .001, η_p^2 = .13, indicating that changes in negative mood over time varied by condition. Follow up pairwise contrasts with Bonferroni correction revealed that following the second inference, only participants in the depressogenic-to-benign condition showed a significant decrease in negative mood across the two inferences (p < .001, 95% CI [4.03, 9.75], d = 0.63), whereas negative mood remained stable in the benign-to-depressogenic condition (p = .15, 95% CI [-0.82, 5.23], d = 0.20), and in the no-shift condition (p = .46, 95% CI [-4.43, 2.2], d = 0.11; see Table 1).

The main effect of time on state rumination was significant, F(1,149) = 13.60, p < .001, η_p^2 = .08, but the main effect of the condition was not, F(2,149) = 2.38, p = .09, η_p^2 = .03. As predicted, the main effect of time was qualified by a significant time by condition interaction, F(2,149) = 22.18, p < .001, η_p^2 = .23. Pairwise contrasts with Bonferroni correction revealed that following the second inference, state rumination significantly decreased in the depressogenic-to-benign condition (*p* < .001, 95% CI [-16.93, -9.88], *d* = -1.41), while it remained stable in the benign-to-depressogenic condition (*p* = .06, 95% CI [-7.30, 0.16], *d* = -0.38), and the no-shift condition (*p* = .26, 95% CI [-1.69, 6.27], *d* = 0.24; see Table 1).

The Effect of Condition on Next-Day Inferences (Hypothesis 2)

The main effect of condition on next-day inference depressive bias was significant, $F(2,134) = 4.45$, $p = .01$, $\eta_p^2 = .06$, indicating that inference depressive bias differed significantly across conditions. Pairwise contrasts with Bonferroni correction revealed that, as predicted, inference depressive bias was significantly lower in the depressogenic-to-benign condition than in the benign-to-depressogenic condition (*p* = .04, 95% CI [0.05, 15.91], *d* = 0.51), and in the no-shift condition (*p* = .02, 95% CI [0.79, 16.70], *d* = 0.56). However, inference depressive bias did not differ significantly in the benign-to-depressogenic condition than in the no-shift condition (*p* = 1.00, 95% CI [-7.37, 8.89], *d* = 0.05; see Tables 1).

Discussion

As predicted, only participants in the depressogenic-to-benign condition showed improved mood and reduced state rumination, while those in the benign-to-depressogenic and the no-shift conditions did not. Notably, there was no significant difference following the first inference (benign vs. depressogenic), likely because the immediate impact of the negative event overshadowed any early inference effects. Additionally, as predicted, next-day inference depressive bias remained lower among participants in the depressogenic-to-benign condition than those in both comparison groups, indicating benefits that extend beyond the immediate session.

These findings indicate that the direction of the shift, rather than inferential flexibility per se, drives cognitive and emotional change. Interpreted within a belief-updating framework, they suggest an attenuation of valence asymmetry: in the depressogenic-to-benign condition, the second (benign) inference functioned as endogenous "good news" that down-weighted the earlier self-generated "bad news" (depressogenic inference), yielding less-depressogenic next-day inferences. Crucially, this aligns with the optimism bias, where weighting internally generated "news" was direction-dependent: a subsequent benign inference overrode a prior depressogenic one, whereas a subsequent depressogenic inference did not similarly override a prior benign one.

These findings left an open question: because the next-day benefits in Study 1 coincided with mood improvements, it was unclear whether the direction-specific effects were due to true asymmetry in updating or state-level changes in affect. A replication was needed to test whether these effects would re-emerge and if next-day inferences would depend on them. This consideration motivated Study 2 to test the robustness and boundary conditions of the effects in Study 1.

Study 2

Method

Participants

The sample size was based on a G*Power analysis, which indicated that a sample of 212 participants would provide 80% power ($1–\beta = 0.80$) to detect a small-to-medium effect size ($f = 0.215$)[4], assuming an alpha level of .05. To account for possible drop out, 223 participants ($M_{age} = 38.51$, $SD = 12.05$, 112 females, 110 males and 1 non-binary) were recruited via Prolific Academic (https://www.prolific.com). Participants self-identified their racial and ethnic backgrounds as follows: 62.8% White, 25.6% Black, 5.4% Mixed, 4.9% Asian, and 0.9% other racial identities. Prolific's prescreening included: English as a native

[4] The effect size estimate was derived from the most conservative analysis in Study 1, in which the effect of condition on next-day inferences was examined while adjusting for brooding as a covariate. In this model, the observed partial eta squared for the group effect was $\eta^2 = 0.044$, corresponding to $f = 0.215$

language, residence in the United States or United Kingdom, 95-100 approval rate and no cognitive impairment. Participants were compensated at a rate of £9 per hour, for each session separately. Fifteen participants were excluded from the study because they did not follow task instructions (e.g., failing to describe a personal event as instructed), 3 were excluded for exceeding the time limit, and 2 were excluded due to incomplete data caused by technical errors. The final sample for the first day analyses included 203 participants (103 women, 99 men, and 1 non-binary). Ten additional participants (5 from the depressogenic-to-benign condition and 5 from the benign-to-depressogenic condition) dropped out before completing the second day and were removed from the analyses pertaining to this day only.

Materials

Inferential Shift of a Personal-Event (ISPE) Assessment Procedure. The task was identical to that described in Study 1.

State and Trait Measures. State measures (inference depressive bias, α=0.71-0.84; state mood, α=0.93; and state rumination, α=0.9-0.94) and trait brooding (α=0.86) were assessed using the same instruments as in Study 1. Questionnaires were administered in the original English version. Additional measures unrelated to the current hypotheses were included as part of a broader study and are not reported here.

Procedure

The experiment was conducted online over two consecutive days using Qualtrics. The procedure was identical to that of Study 1, except for the target sample (see above).

Results

The Effect of Condition on Inferential Shifting (Manipulation Check)

The main effect of time, $F(1,197) = 6.83$, $p = .010$, $\eta_p^2 = .03$, and condition, $F(2,197) = 36.08$, $p < .001$, $\eta_p^2 = .27$, were both significant. As predicted, these effects were qualified by a significant time by condition interaction, $F(2,197) = 105.04$, $p < .001$, $\eta_p^2 = .52$, suggesting that changes in inference depressive bias differed substantially by condition.

Follow up pairwise contrasts with Bonferroni correction revealed that, as expected, inference depressive bias significantly decreased from the first to the second inference in the depressogenic-to-benign condition ($p < .001$, 95% CI [14.11, 22.44], $d = 1.54$), increased in the benign-to-depressogenic condition ($p < .001$, 95% CI [-27.77, -19.90], $d = -2.01$), and did not change in the no-shift condition ($p = .071$, 95% CI [-7.80, 0.32], $d = -0.31$; see Table 1).

Effects of Condition on State Measures (Hypothesis 1)

The Effects of Condition and Time on Negative Mood and State Rumination

The omnibus ANOVA predicting negative mood, revealed a significant interaction between time (across the three time points) and condition, $F(4, 394) = 2.71$, $p = .03$, $\eta_p^2 = .027$, demonstrating that changes in negative mood over time varied by condition. Similarly, predicting state rumination, the interaction between time (across three time points) and condition was also significant, $F(4, 394) = 4.47$, $p = .002$, $\eta_p^2 = .043$, demonstrating that changes in state rumination over time varied by condition. To follow up these significant interactions, we examined each experimental phase separately.

The Effect of the First Inference on Negative Mood and State Rumination

The main effect of time was significant, $F(1,197) = 163.67$, $p < .001$, $\eta_p^2 = .45$, indicating a significant increase in negative mood across conditions from baseline to following the first inference. The main effect of condition, $F(2,197) = 2.64$, $p = .074$, $\eta_p^2 = .03$, and the time by condition interaction, $F(2,197) = .66$, $p = .518$, $\eta_p^2 = .007$ were both non-significant.

The main effect of time on state rumination was significant, $F(1,197) = 202.16$, $p < .001$, $\eta_p^2 = .51$, indicating a substantial increase in state rumination from baseline to following the first inference across conditions. The main effect of condition, $F(2,197) = 1.60$, $p = .20$,

η_p^2 = .02 was not significant. However, the time by condition interaction was statistically significant, $F(2,197) = 5.33$, $p = .006$, $\eta_p^2 = .051$. Pairwise contrasts with Bonferroni correction revealed that rumination increased significantly across all conditions (all *p*s < 0.05), but most strongly in the no-shift condition. At Time 2, levels were significantly higher in the no-shift than in the benign-to-depressogenic condition (p = .042, 95% CI [0.22, 16.65], d = 0.42). Differences between no-shift and depressogenic-to-benign (p = 1.00, 95% CI [−5.33, 11.55], d = 0.16) and between the two shift conditions (p = .371, 95% CI [−13.65, 2.99], d = 0.27; see Table 1) were not significant.

The Effect of the Second Inference on Negative Mood and State Rumination

The main effect of time was significant, $F(1,197) = 4.97$, $p = .027$, $\eta_p^2 = .025$, indicating an increase in negative mood across time. The main effect of condition was not significant, $F(2,197) = 0.35$, $p = .707$, $\eta_p^2 = .004$, but the predicted time by condition interaction was significant, $F(2,197) = 4.01$, $p = .02$, $\eta_p^2 = .039$, indicating that changes in negative mood over time varied by condition. Pairwise contrasts with Bonferroni correction revealed that negative mood did not change significantly in the depressogenic-to-benign condition (*p* = .313, 95% CI [-1.64, 5.1], d = 0.13), while it increased significantly in the benign-to-depressogenic condition (p = .007, 95% CI [1.24, 7.61], d = 0.33), and the no-shift condition (p = .026, 95% CI [-0.45, 7.02], d = 0.27; see Table 1).

The main effect of condition on state rumination, $F(2,197) = 2.48$, $p = .09$, $\eta_p^2 = .03$, and of time, $F(1,197) = 1.78$, $p = .18$, $\eta_p^2 = .01$ were both non-significant. However, the predicted time by condition interaction was significant, $F(2,197) = 8.81$, $p < .001$, $\eta_p^2 = .08$, indicating that changes in state rumination across inferences varied by condition. Follow up pairwise contrasts with Bonferroni correction revealed that in the depressogenic-to-benign condition state rumination significantly decreased (*p* = .02, 95% CI [0.75, 7.77], *d* = 0.43), whereas in the benign-to-depressogenic condition there was a significant increase in state rumination (p = .001, 95% CI [-9.24, -2.60], d = -0.59), and in the no-shift condition it remained stable (p = .18, 95% CI [-5.76, 1.08], d = -0.23; see Table 1).

The Effect of Condition on Next-Day Inferences (Hypothesis 2)

The main effect of the condition was significant, $F(2,189) = 12.55$, $p < .001$, $\eta_p^2 = .12$, indicating that inference depressive bias differed significantly across conditions. Pairwise contrasts with Bonferroni correction revealed that inference depressive bias was significantly higher in the no-shift condition compared to both the benign-to-depressogenic condition ($p < .001$, 95% CI [6.53, 20.70], d = 0.81), and the depressogenic-to-benign condition ($p < .001$, 95% CI [4.55, 19.17], d = 0.70). Contrary to prediction and to our findings in Study 1, no significant difference was observed between the benign-to-depressogenic and depressogenic-to-benign conditions (p = 1.00, 95% CI [-9.08, 5.58], d = -0.10; see Tables 1).

Discussion

The findings of Study 2 partially replicated those of Study 1. The findings concerning the immediate effects of the shifts were similar to those of study 1, but were weaker. Negative mood and state rumination increased after the first inference across all conditions, possibly due to the dominant influence of the negative event itself, which may have overshadowed any early inference effects. Following the second inference, only participants in the depressogenic-to-benign condition showed emotional recovery—mood remained stable and state rumination decreased—while participants in both the benign-to-depressogenic and the no-shift conditions showed increased mood and state rumination.

In the current study, contrary to initial predictions and to the findings of Study 1, both the depressogenic-to-benign and benign-to-depressogenic conditions led to reduced next-day inference depressive bias compared to the no-shift group. Taken together, the next-day effects suggest that flexibility per se—practicing a shift regardless of direction—can foster more benign inferences over time, whereas direction is critical for immediate affective relief.

General Discussion

The current research set out to examine (a) immediate emotional effects of inferential shifts, (b) next-day effects on inference depressive bias and (c) differential effects of shift direction. We also explored the moderating role of trait brooding on the immediate and delayed effects. We predicted that an inferential shift, and especially a shift from a depressogenic to a benign inference, would decrease negative mood and state rumination. We also predicted that a reduced tendency to generate depressive inferences on the next day, reflective of an inferential update, would occur in both of the shift conditions, but mostly in the depressogenic-to-benign shift condition. Finally, we predicted that trait brooding would attenuate these effects.

Across both studies, the manipulation successfully reduced the tendency to generate depressive inferences, reaffirming the validity of our paradigm. For Hypothesis 1, results diverged across studies. In Study 1, predictions were fully supported: only participants in the depressogenic-to-benign condition showed significant reductions in negative mood and state rumination after the second inference, whereas the other two groups remained unchanged. In Study 2, however, support was partial. Rumination again followed the predicted direction-specific pattern—decreasing in the depressogenic-to-benign condition, increasing in the benign-to-depressogenic condition, and remaining stable in no-shift—but mood did not improve uniquely in the depressogenic-to-benign group. Instead, this group maintained stable mood while both comparison groups worsened. For Hypothesis 2, the results were likewise mixed. In Study 1, next-day inference depressive bias was lowest in the depressogenic-to-benign condition compared to both other groups, as predicted. In Study 2, however, both shift conditions (regardless of direction) produced lower next-day depressive bias than no-shift, with no difference between them. Finally, consistent with our exploratory hypothesis, trait brooding was associated with higher overall levels of depressive bias, mood disturbance, and rumination, but—contrary to predictions—did not moderate the benefits of shifting in either study.

These findings suggest that addressing our initial question—whether improvements in mood, rumination, and reduced tendency to make depressogenic inferences on the next-day result from shifting away from negative thoughts, or from a more general flexibility in thinking—is not straightforward. We demonstrated that immediate gains in mood and state rumination were only observed when shifting from a depressogenic to a benign inference but not the reverse. These findings align with work on belief-updating asymmetry showing that individuals more readily integrate favourable as compared to unfavourable information when revising beliefs (Garrett & Sharot, 2017). Similar updating asymmetry is shown among depressed and dysphoric individuals who show reduced updating from depressogenic to benign beliefs compared to the reverse (Zabag et al., 2022; 2025). Our findings extend this work by showing that even in the absence of external feedback, self-initiated updating follows a comparable valence-dependent pattern.

The fact that immediate emotional benefits emerged only when participants shifted from depressogenic to benign inferences may reflect a recency effect, whereby the final inference—especially when benign—dominates current mood and cognition (Anderson, 1981). Alternatively, these effects may reflect a regulatory sequencing process, in which the order of cognitive processing determines emotional outcomes. This interpretation is particularly important given a central feature of our design: in both experimental conditions, participants made both a depressogenic and a benign inference, differing only in the order or direction of the shift. This structure isolated the effect of inferential sequencing, previously shown to be critical for emotional outcomes. Supporting this view, Yoon and Joormann (2012) demonstrated that distraction preceding rumination allows emotional arousal to subside and fosters cognitive distance, whereas rumination first sustains a self-immersed focus that is harder to regulate. This pattern implies that the direction-specific improvements observed reflect regulatory processes rather than mere cognitive flexibility. Their explanation emphasizes changes in arousal and cognitive distance as key mediators of adaptive outcomes, aligning with our results and suggesting that the benefits of shifting from depressogenic to benign inferences may arise from similar regulatory mechanisms—reducing emotional arousal and promoting a more self-distanced, reflective stance.

While immediate emotional improvements depended on direction, next-day benefits emerged across both shift directions, suggesting that broader inferential flexibility also contributes to lasting change. Specifically, both shift conditions showed more benign next-day inferences compared to the no-shift control, indicating that engaging in any inferential change—regardless of direction—promotes more adaptive inference patterns over time. Fundamentally, whereas traditional belief-updating paradigms often highlight asymmetry following external feedback (e.g., Sharot et al., 2011), our findings show that similar directional biases can occur without new external evidence, when the new inferences are generated endogenously from memory. This internally driven inferential updating provides a complementary perspective to traditional belief-updating tasks and may capture additional aspects of belief revision, common in everyday life.

The overall pattern of the results suggests that disengaging from maladaptive inferences supports immediate affective regulation, whereas repeated engagement in inferential updating may gradually strengthen longer-term cognitive flexibility. Thus, short-term mood improvements appear to depend on directional shifts away from depressogenic inferences, whereas sustained cognitive benefits may reflect a more general capacity for inferential flexibility. By distinguishing direction-specific relief from direction-independent updating, our design helps clarify how internally generated belief change contributes to both the regulation of negative affect and the broader maintenance of psychological adjustment.

Both studies showed next-day effects of shift direction, but the size of this advantage differed, likely reflecting emotional context. In Study 1, mood improvement in the depressogenic-to-benign group likely facilitated consolidation of benign inferences, potentially facilitating memory integration of benign content (Forgas et al., 2005), producing direction-specific benefits. In contrast, in Study 2, next-day benefits emerged in both shift conditions despite no mood changes, indicating that active engagement in inferential shifting alone—through cognitive flexibility and metacognitive control—may enhance adaptive inference retention. Together, these findings highlight that the persistence of cognitive change can arise from either affective or purely cognitive mechanisms, depending on emotional context.

The co-occurrence of mood improvement and stronger next-day gains fits accounts in which negative affect impedes positive updating (Kube & Korn, 2025) and with state-dependent cognition and mood-congruent memory. By state-dependent and mood-congruent processes we mean that the affect present during encoding or rehearsal biases both what gets consolidated and what is later accessible (Blaney, 1986; Bower, 1991; Faul & LaBar, 2023). In Study 1, only depressogenic-to-benign shifts improved mood on day 1. That improvement likely strengthened the consolidation and later accessibility of benign inferences, plausibly via integration into associative networks (Forgas et al., 2005), and was associated with direction-specific next-day benefits.

However, in Study 2, mood did not differ across conditions, yet next-day gains still emerged. One possibility is that unmeasured differences (such as lower event intensity or greater temporal distance from the event) reduced affective load and muted mood change despite cognitive shifts. This pattern points to a second pathway that does not rely on affective change. By this we mean that the act of generating an alternative inference recruits cognitive flexibility (considering multiple causal accounts for the same event) and metacognitive control (monitoring and selecting the more adaptive account), which may support organization, rehearsal, and retention of the chosen inference even without mood shifts (Genet et al., 2013; Hertel et al., 2023). Thus, persistence can arise either because mood facilitates consolidation and retrieval, or because flexible, controlled inference generation leaves a stronger cognitive trace. Clearly, further research is needed to test these explanations.

This tentative account suggests that transient mood states may bias how new inferences are integrated. While emotional change and longer-term revision appear related, they are not identical. Because we did not measure memory for Day 1 inferences, the role of consolidation remains uncertain. Future research should test recall directly, especially given links between depression, rumination, and memory deficits (James et al., 2021), to clarify how affect and memory influence cognitive change.

Beyond these state-level effects, trait brooding was consistently associated with a more depressogenic profile across conditions and time points. However, brooding did not alter the immediate benefits of guided inferential shifts, indicating that individuals high in brooding can still improve when shifts are supported. Prior work suggests that rumination can hinder memory integration yet can be mitigated by structure (e.g., Hertel et al., 2023), but our evidence for reduced durability among high brooders is mixed across studies and should be treated as preliminary.

Clinically, these findings may suggest that interventions that target either the direction of the shift or inferential flexibility may be beneficial, depending on the desired outcome. Techniques that explicitly train individuals to shift away from depressogenic inferences toward benign alternatives may provide acute emotional relief, supporting mood regulation and reducing rumination—processes central to cognitive-behavioral therapies (see also Perlman et al., 2024). In parallel, incorporating flexibility-enhancing components that encourage individuals to generate and evaluate multiple causal interpretations, regardless of valence, may strengthen long-term cognitive adaptability and resilience to stress. Such approaches converge with recent evidence linking cognitive flexibility to symptom reduction and improved emotion regulation across disorders (Jacobsen et al., 2023; Koshikawa et al., 2022; Zheng et al., 2024) and with frameworks identifying biased and inflexible interpretation updating as transdiagnostic vulnerability markers (Vos et al., 2025). By integrating direction-specific inferential updating with broader flexibility training, therapeutic interventions may more effectively target both the immediate emotional and enduring cognitive mechanisms that sustain maladaptive belief systems.

There are several limitations to this study. First, although the use of self-relevant, internally generated inferences enhances ecological validity, it also introduces variability in content and emotional salience, which may have increased noise and limited sensitivity to condition effects. In addition, we relied on self-report measures, which cannot fully capture objective or behavioral aspects of cognitive and emotional processes. Future research could address these issues by incorporating standardized coding methods such as the Content Analysis of Verbatim Explanations (CAVE; Schulman et al., 1989; Abu-Saleh et al., in preparation) or other behavioral indices of inference updating. Second, our non-clinical populations limit the generalizability of findings to individuals with depressive disorders, who may differ in baseline depressive bias, flexibility, and responsiveness to inferential shifts. Future studies should therefore examine clinical samples and test whether such shifts extend to more naturalistic settings over time. Third, the control condition required participants to generate two inferences, which may have inadvertently limited the comparison to situations in which people generate multiple inferences. Moreover, we did not assess participants' spontaneous inferences before the manipulation. While doing so would strengthen claims about updating, it also risked contaminating the manipulation itself. Future research should explore ways to balance experimental control with ecological validity when designing inference-shift paradigms.

Conclusion

This research examined how the direction of inferential shifts—depressogenic to benign versus benign to depressogenic—affects mood, state rumination, and persistence of depressogenic inferences. Across both studies, the depressogenic-to-benign shift reliably reduced state rumination; it reduced negative mood only in Study 1, with mood stable in Study 2. Next-day inferences were more benign after both shift conditions in Study 2 (highlighting flexibility), whereas in Study 1 only the depressogenic-to-benign shift conferred an advantage (emphasizing direction). Together, these patterns indicate two complementary routes to change—an affect-facilitated consolidation pathway and a flexibility-practice pathway—and position inferential shifting as an endogenous form of belief updating that can down-weight prior depressogenic inferences. Interventions should cultivate the skill of shifting and support emotional contexts that aid consolidation (e.g., reducing negative affect). Future research should extend this work to clinical populations, assess durability in daily life, and probe memory mechanisms that sustain change.

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Saleh; Resources: N. Mor; Data Curation: B. Abu Saleh and B. Perlman; Writing – Original Draft: B. Abu Saleh, B. Perlman and N. Mor; Writing – Review & Editing: B. Abu Saleh, B. Perlman and N. Mor; Visualization: B. Abu Saleh; Supervision: N. Mor; Project Administration: B. Abu Saleh and N. Mor; Funding Acquisition: B. Abu Saleh and N. Mor. All authors approved the final version of the paper for submission.

Conflicts of Interest:

The authors declare that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Table 1

Descriptive Statistics of the Variables in the Two Studies

	Study 1			Study 2		
	Depressogenic-to-Benign (n = 57)	Benign-to-Depressogenic (n = 53)	No-Shift (n = 45)	Depressogenic-to-Benign (n = 64)	Benign-to-Depressogenic (n = 71)	No-Shift (n = 68)
Trait Measure						
Brooding	11.65 (3.58)	10.47 (3.44)	11.67 (3.3)	10.43 (2.9)	10.56 (3.47)	11.19 (3.2)
State Measures						
PANAS						
Day 1						
Baseline	40.6 (21.8)	42.53 (23.2)	43.39 (24.3)	40.16 (21.76)	33.01 (24.33)	34.2 (24.33)
Following the first inference	54.59 (20.53)	53.95 (21.66)	52.94 (24.14)	54.56 (24.31)	49.14 (26.54)	51.53 (24.29)
Following the second inference	47.57 (21.56)	56.59 (22.23)	53.63 (22.76)	52.98 (23.15)	53.51 (27.06)	55.29 (26.2)
BSRI						
Day 1						
Baseline	46.41 (22.02)	43.25 (19.27)	46.5 (25.88)	42.35 (21.72)	38.58 (25.13)	41.7 (24.46)
Following the first inference	57.13 (22.23)	50.1 (19.39)	58.01 (25.3)	56.83 (23.53)	52.08 (26.78)	62.68 (20.8)
Following the second inference	43.38 (19.43)	53.83 (20.68)	55.45 (25.21)	52.79 (22.69)	58.11 (27.37)	64.84 (22.52)
CSQ						
Day 1						
Following the first inference	67.6 (16.06)	50.05 (15.97)	70.83 (14.63)	68.94 (14.52)	53.77 (16.22)	76.32 (14.78)

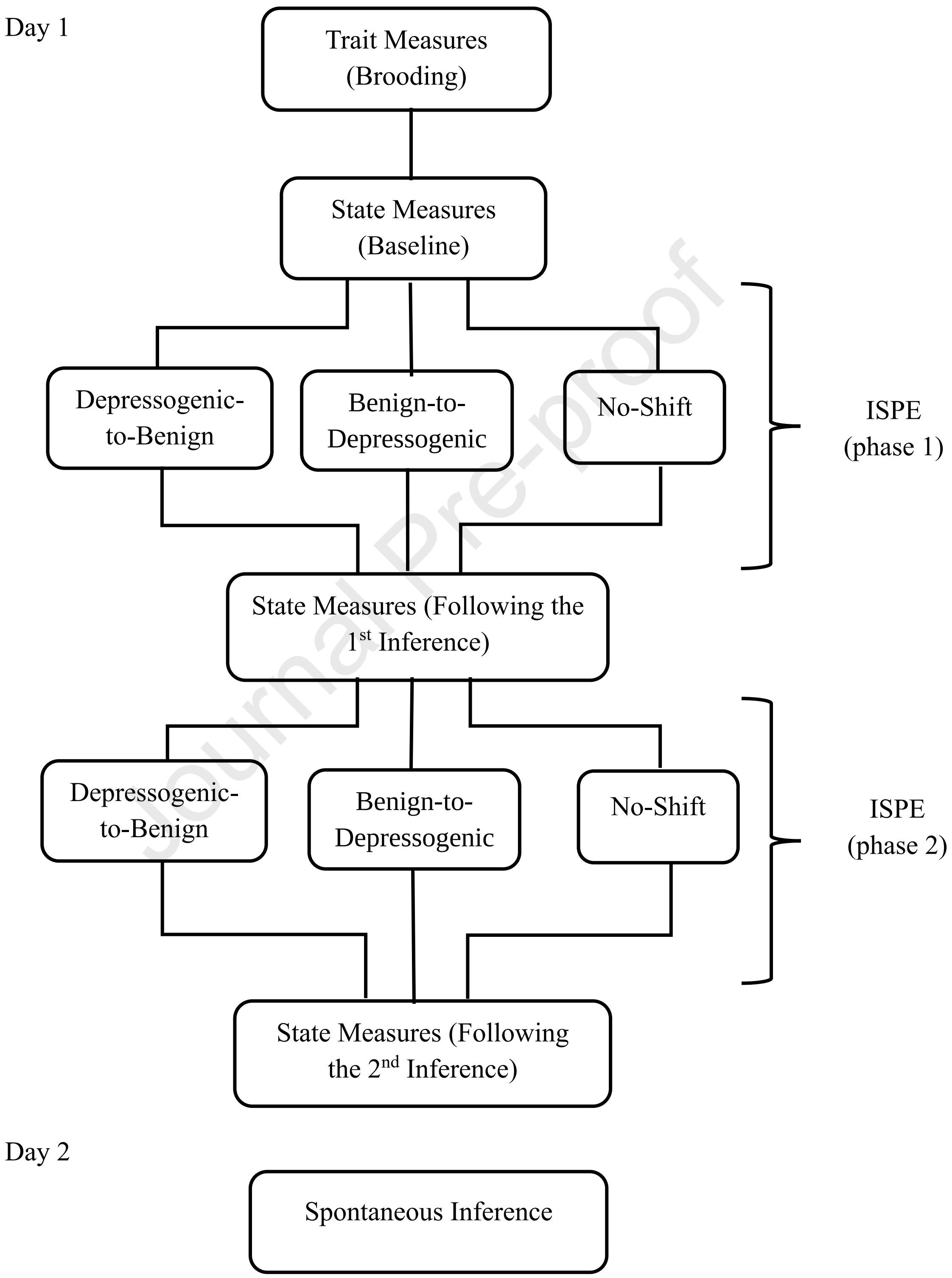
Following the second inference	43.14 (15.44)	67.63 (15.21)	65.41 (15.42)	50.53 (18.05)	77.62 (13.46)	79.94 (13.31)
Day 2 [a]						
Following the spontaneous inference	55.16 (19.07)	61.65 (15.07)	64.29 (16.52)	62.31 (16.44)	60.71 (20.42)	75.21 (15.06)

Note. PANAS The Positive and Negative Affect Schedule (Mean scores for negative mood and reverse-scored positive mood are included here); *BSRI* The Brief State Rumination Inventory; *CSQ* Cognitive Style Questionnaire; adapted standard deviations in parenthesis.

[a] The number of participants on day 2 was reduced due to dropout. Final sample sizes for the depressogenic-to-benign, benign-to-depressogenic, and no-shift, respectively: Study 1, n = [49], n = [44], n = [47]; Study 2, n = [59], n = [68], n = [66].

Figure 1.

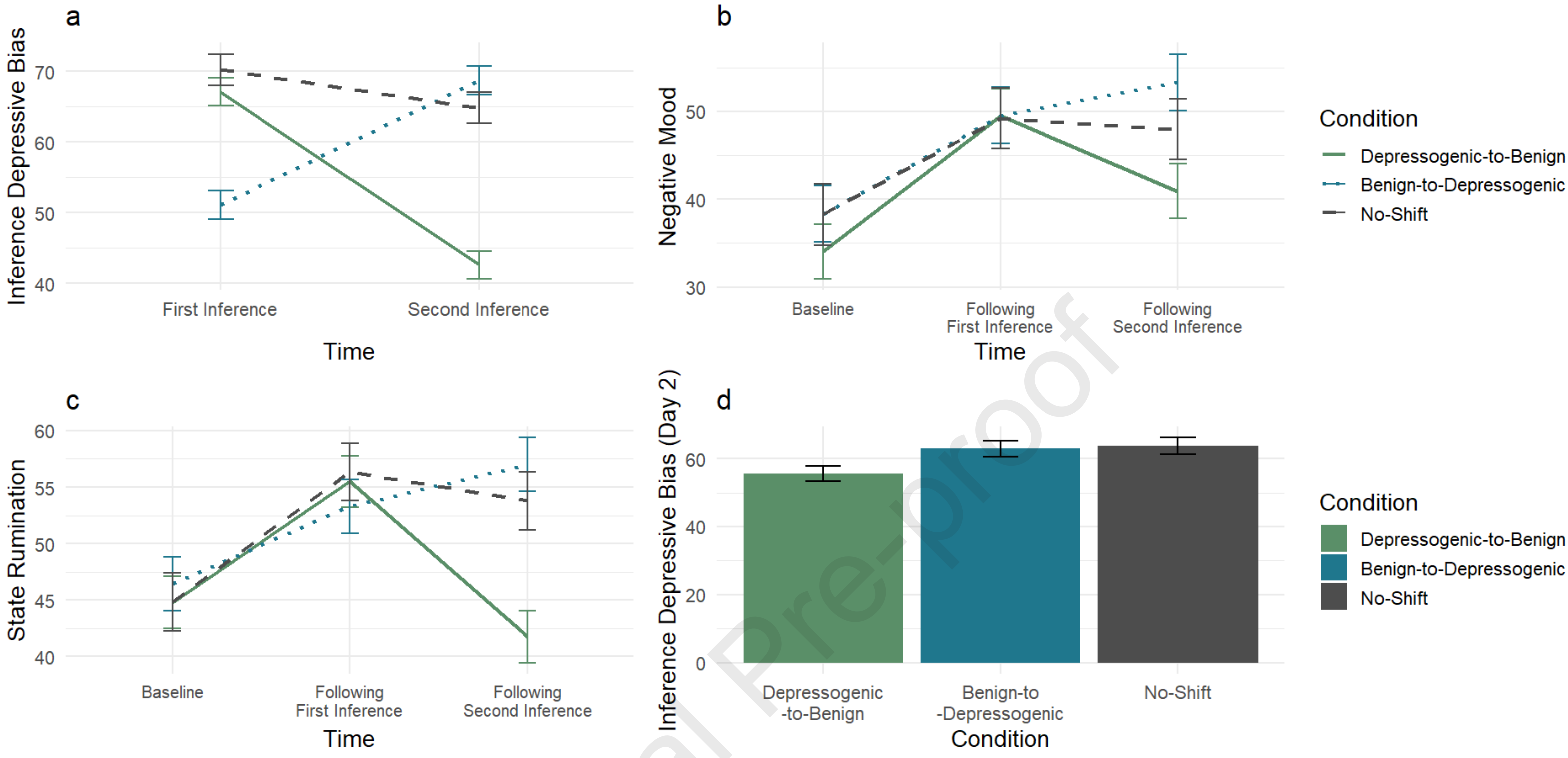
Procedure of both studies.



Note. ISPE: Inferential Shift of a Personal-Event

Figure 2.

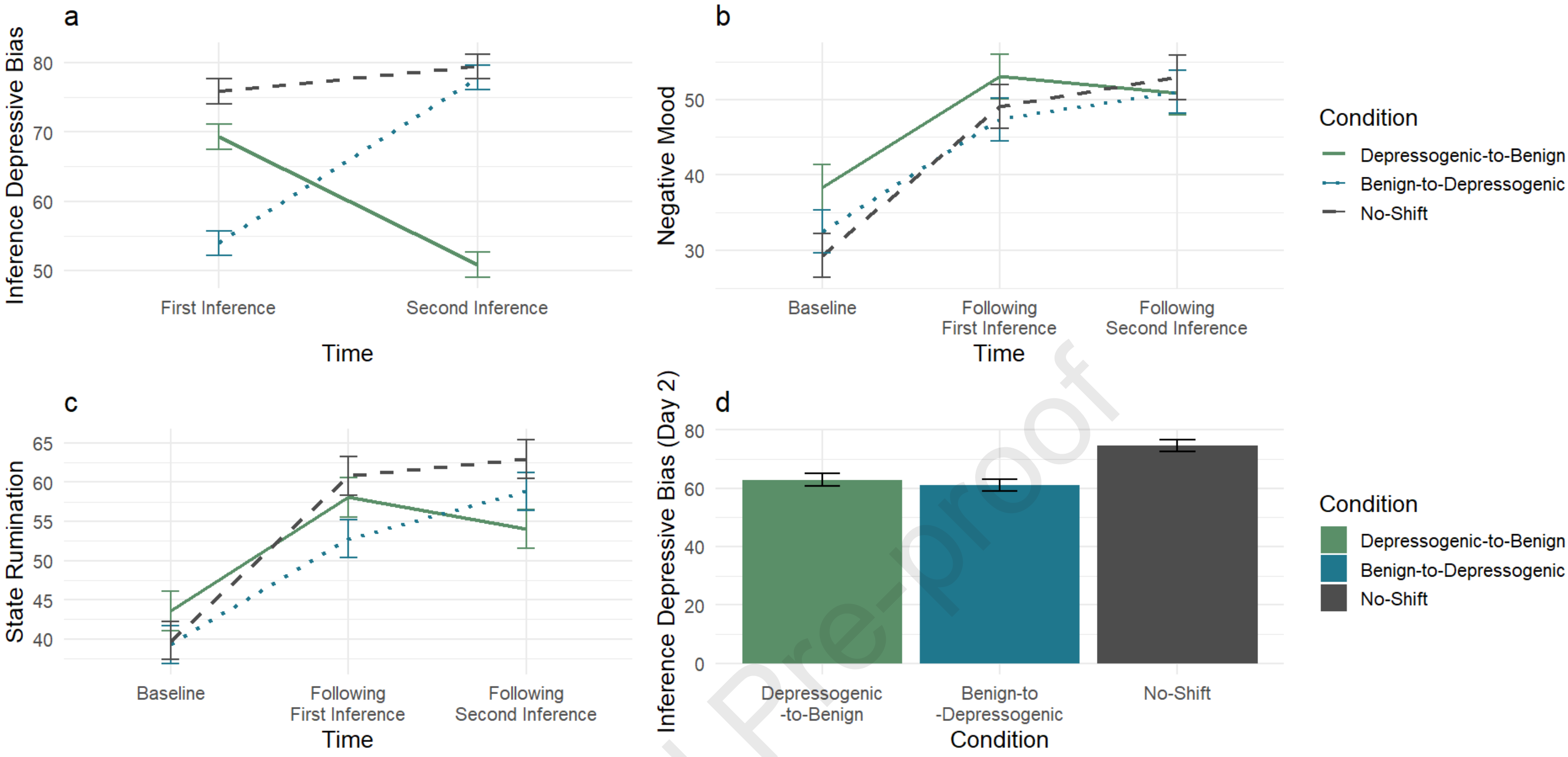
State-Level Measures of Mood, Rumination, and Cognitive Inference in Study 1.



Note. The effect of condition on (a) inference depressive bias, (b) negative mood, (c) state rumination & (d) inference depressive bias on the next day. Error bars represent 1 standard error from the mean.

Figure 3.

State-Level Measures of Mood, Rumination, and Cognitive Inference in Study 2.



Note. The effect of condition on (a) inference depressive bias, (b) negative mood, (c) state rumination & (d) inference depressive bias on the next day. Error bars represent 1 standard error from the mean.

Appendix A

Experimental Instructions

The following instructions pertain to the depressogenic-to-benign condition. In this condition, participants first describe a negative event, then generate a depressogenic inference, followed by a shift to a benign inference. In the benign-to-depressogenic condition, the order of the inferences is reversed. In the no-shift condition, both inferences are depressogenic.

Negative Event

For the following task, please think about a negative event that you fear might happen in the future. The event can be from any area of your life (e.g., work, school, family, friends, romantic relationships), except for events concerning death or illness. Focus on a significant negative event that you often think about. Your thoughts may relate to the meaning of the event, how to prevent it, or fears about its consequences.

Next, describe the negative event you fear. Try to focus on a specific situation that takes place at a particular time and location. If the event spans a period of time, choose one situation that best reflects your fear. Imagine yourself in the event and describe it step by step, as if writing a movie script. Describe the event as it would occur in reality, without offering explanations or interpretations.

Please write between 400–1,200 characters.

Depressogenic Inference

Now, consider a likely cause for the negative event you described. Choose a cause that you believe could lead to similar events in the future and could impact other areas of your life. Focus on an aspect of yourself—your qualities, abilities, or personality—that might lead to this event. Reflect for a few moments, and then write a detailed description of this cause.

In your response, explain what about yourself might cause the event and why this cause may lead to similar negative events or consequences in the future.

Please write between 400–850 characters.

Benign Inference Shift

Now, consider a different cause for the negative event, one that relates to external and contextual circumstances. Identify a factor that may lead to the specific event you described, but is unlikely to recur or affect other areas of your life. Choose one main cause that you truly believe could lead to this event.

In your description, explain what about the current situation may cause the event and why it is unlikely to result in future similar events or broader consequences.

Please write between 400–850 characters.

Appendix B

Brooding Results

Study 1

The Effect of Condition on Inference Depressive Bias

Brooding significantly predicted inference depressive bias, $F(1,149) = 21.31$, $p < .001$, $\eta_p^2 = .13$, but the time by brooding interaction was not significant, $F(1,149) = 0.76$, $p = .386$, $\eta_p^2 = .01$. The three-way interaction between time, condition and brooding was also not statistically significant, $F(2,149) = 0.04$, $p = .958$, $\eta_p^2 = .001$.

Effects of Condition on State Measures

The effect of the First Inference

Brooding significantly predicted negative mood, $F(1,149) = 40.34$, $p < .001$, $\eta_p^2 = .21$, but the time by brooding interaction was not significant, $F(1,149) = 1.26$, $p = .263$, $\eta_p^2 < .01$. The three-way interaction between time, condition and brooding was also not statistically significant, $F(2,149) = 0.58$, $p = .563$, $\eta_p^2 < .01$.

Brooding significantly predicted state rumination, $F(1,149) = 149.15$, $p < .001$, $\eta_p^2 = .5$, The time by brooding interaction was non-significant, $F(1,149) = 0.63$, $p = .43$, $\eta_p^2 = .00$, indicating that brooding did not moderate changes in state rumination at this stage. The three-way interaction between time, condition and brooding was also non-significant $F(2,149) = 1.48$, $p =.23$, $\eta_p^2 = .02$.

The effect of the Second Inference

Brooding significantly predicted negative mood, $F(1,149) = 22.52$, $p < .001$, $\eta_p^2 = .13$. Additionally, the two-way interaction of time by brooding was significant, $F(1,149) = 7.58$, $p = .007$, $\eta_p^2 = .04$, indicating that the effect of brooding on negative mood was less pronounced following the second compared to the first inference. However, the two-way interaction of condition by brooding, $F(2,149) = 0.97$, $p = .38$, $\eta_p^2 = .01$, and the three-way interaction of time by condition by brooding were non-significant, $F(2,149) = 0.97$, $p = .38$, $\eta_p^2 = .01$, indicating that brooding did not moderate the differential time-course of negative mood across conditions.

Brooding significantly predicted state rumination, $F(1,149) = 103.49$, $p < .001$, $\eta_p^2 = .41$, indicating that participants with higher levels of brooding reported greater overall state rumination. However, the time by brooding interaction did not reach significance, $F(1,149) = 3.26$, $p = .07$, $\eta_p^2 = .02$, suggesting that changes in state rumination over time were not significantly moderated by brooding. Likewise, the condition by brooding interaction was not significant, $F(2,149) = 1.73$, $p = .18$, $\eta_p^2 = .02$, indicating that the effect of condition on average rumination levels did not vary as a function of brooding. The three-way interaction between time, condition and brooding was non-significant $F(2,149) = 0.40$, $p = .67$, $\eta_p^2 = .00$.

The Effect of Condition on Next-Day Inferences

The effect of brooding on inference depressive bias was significant, $F(1,134) = 11.87$, $p < .001$, $\eta_p^2 = .08$, indicating that higher levels of brooding were associated with greater inference depressive bias. The interaction of condition by brooding was not significant, $F(2,134) = 1.55$, $p = .22$, $\eta_p^2 = .02$, suggesting that the relationship between brooding and inference depressive bias did not differ across conditions.

Study 2

The effect of condition on inference Depressive Bias

Brooding significantly predicted inference depressive bias, $F(1,197) = 17.50$, $p < .001$, $\eta_p^2 = .08$. However, the time by brooding interaction was not significant, $F(1,197) = 0.01$, $p = .946$, $\eta_p^2 < .01$, nor was the three-way interaction between time, condition and brooding, $F(2,197) = 0.33$, $p = .721$, $\eta_p^2 = .003$.

Effects of Condition on State Measures

The Effect of the First Inference

Examining negative mood, the three-way interaction between time, condition and brooding was significant, $F(2,197) = 6.37$, $p = .002$, $\eta_p^2 = .061$, suggesting that the change in negative mood over time varied by condition and was moderated by individual differences in brooding. Within the no-shift condition, the influence of brooding on levels of negative mood attenuated over time whereas it remained relatively stable in the depressogenic-to-benign and benign-to-depressogenic conditions.

To follow-up on the three-way interaction between time, condition and brooding, separate within-group analyses were conducted for each condition, examining the change in negative mood and its moderation by brooding. Importantly, participants in the no-shift condition, showed a significant increase in negative mood, $F(1,66) = 67.73$, $p < .001$, $\eta_p^2 = .26$. This change was significantly moderated by trait brooding, $F(1,66) = 6.37$, $p = .002$, $\eta_p^2 = .061$. In the no-shift condition, negative mood increased from baseline to post-inference, $F(1,66) = 67.73$, $p < .001$, $\eta p^2 = .26$. This time effect was significantly moderated by trait brooding, $F(1,66) = 6.37$, $p = .002$, $\eta p^2 = .06$: as shown in Figure A (Appendix B), predicted mood plotted at −1 SD, M, and +1 SD of brooding indicates that the brooding–mood association was strong at baseline but attenuated after the first inference (i.e., reduced separation between low- and high-brooding lines). In both the benign-to-depressogenic and depressogenic-to-benign conditions, the main effect time was significant (benign-to-depressogenic: $F(1,69) = 55.99$, $p < .001$, $\eta_p^2 = .22$; depressogenic-to-benign: $F(1,62) = 41.4$, $p < .001$, $\eta_p^2 = .17$), but the time by brooding interaction was not (all *p*s > 0.05). the time by brooding interaction were significant, $F(1,197) = 4.51$, $p = .04$, $\eta_p^2 = .02$, and were qualified by a significant three-way interaction, $F(2,197) = 4.30$, $p = .02$, $\eta_p^2 = .04$. These findings suggest that negative mood generally increased across all conditions and levels of negative mood were linked to levels of brooding.

Regarding Rumination, to follow-up on the three-way interaction between time, condition and brooding, separate within-group analyses were conducted for each condition, examining the change in state rumination. In the no-shift condition, participants showed a main effect of time reflecting a significant increase in state rumination, $F(1,66) = 96.19$, $p < .001$, $\eta_p^2 = .59$, as well as a significant time by brooding interaction, $F(1,66) = 10.78$, $p = .002$, $\eta_p^2 = .14$, indicating the effect of brooding on state rumination was less pronounced following the second compared to the first inference. In both the benign-to-depressogenic and depressogenic-to-benign conditions, the main effect time was significant (benign-to-depressogenic: $F(1,69) = 51.89$, $p < .001$, $\eta_p^2 = .43$; depressogenic-to-benign: $F(1,62) = 55.23$, $p < .001$, $\eta_p^2 = .47$), but the time by brooding interaction was not significant (all ps > 0.05).

These findings suggest that state rumination increased in all conditions and higher brooding was linked to higher state rumination at all times. Within the no-shift condition, rumination was more strongly associated with baseline levels of state rumination than those following the first inference.

The effect of the Second Inference

Brooding significantly predicted negative mood across time points, $F(1,197) = 39.85$, $p < .001$, $\eta_p^2 = .17$. However, neither the time by brooding interaction, $F(1,197) = 0.03$, $p = .86$, $\eta_p^2 < .001$, nor the three-way interaction between time, condition and brooding was significant, $F(2,197) = 0.57$, $p = .565$, $\eta_p^2 = .006$.

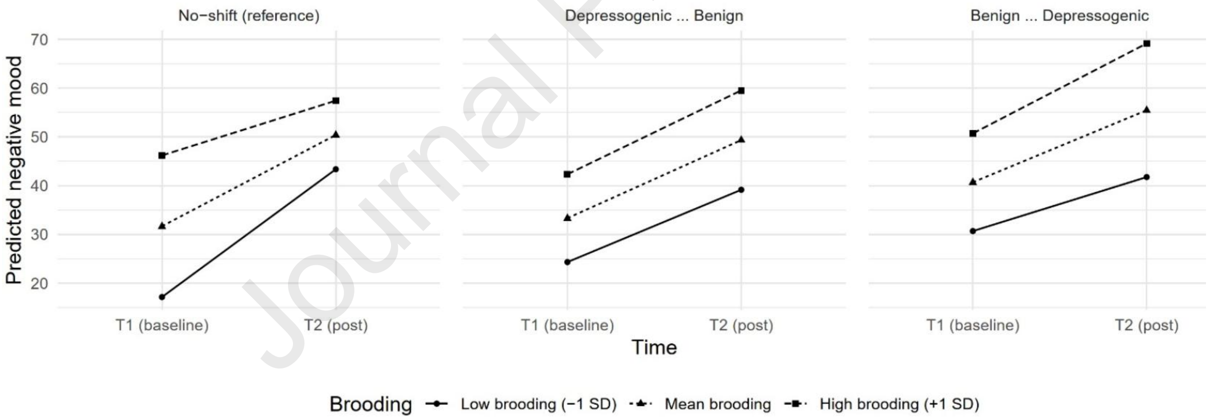
Brooding significantly predicted overall levels of state rumination, $F(1,197) = 74.93$, $p < .001$, $\eta_p^2 = .28$. However, the time by brooding interaction was not significant, $F(1,197) = 3.61$, $p = .06$, $\eta_p^2 = .02$ as was the three-way interaction between time, condition and brooding, $F(2,197) = 0.11$, $p = .90$, $\eta_p^2 = .001$. These findings suggest that condition-specific effects on state rumination became more pronounced in the later phase of the experiment, but were not significantly moderated by brooding.

The Effect of Condition on Next-Day Inferences

The main effect of brooding was significant, $F(1,189) = 15.38$, $p < .001$, $\eta_p^2 = .08$, indicating that higher levels of brooding were associated with greater next-day inference depressive bias. The condition by brooding interaction was not significant, $F(2,187) = 0.25$, $p = .781$, $\eta_p^2 = .003$, suggesting that this relationship did not differ across experimental conditions.

Figure A.

Predicted Negative Mood Over Time by Brooding Level Within Each Condition.



Highlights

- Tested effects of shift direction and flexibility on emotional outcomes and next-day inferences.
- Negative-to-positive inferential shifts improved mood and reduced state rumination.
- Negative-to-positive shifts (Study 1) and flexibility (Study 2) affected next-day inferences.
- Brooding did not moderate the effects of inferential shifts on mood or rumination.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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