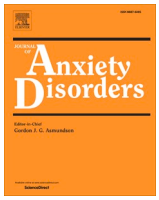
Journal of Anxiety Disorders 107 (2024) 102930



Contents lists available at ScienceDirect

Journal of Anxiety Disorders

journal homepage: www.elsevier.com/locate/janxdis





# A within-person test of the metacognitive model: Daily dynamics between metacognitive beliefs, metacognitive strategies, and negative affect

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ARTICLE INFO

*Keywords:*
Metacognitive beliefs
Metacognitive strategies
Cognitive attentional syndrome
Emotional regulation
Negative affect

ABSTRACT

The metacognitive model of psychological disorders highlights that emotional distress is maintained by metacognitive strategies, which are related to underlying metacognitive beliefs. Considerable empirical evidence has supported the role of metacognitions in psychopathology, but few studies have examined the suggested links between metacognitive beliefs, metacognitive strategies, and symptoms within individuals. Within-person effects provide better empirical tests of theory-based hypotheses derived from clinical models as they relate to change at the individual level. Thus, the current study sought to test central predictions from the metacognitive model at the within-person level using Dynamic Structural Equation Modelling (DSEM). A sample of 222 participants gathered at convenience participated in a 26-day long assessment period where they reported daily measures of metacognitive beliefs, metacognitive strategies, and negative affect. Temporal precedence and bidirectional relations between the variables, and the possible day-to-day and within days mediation role of metacognitive strategies between metacognitive beliefs and negative affect, were tested. When controlling for previous days effects, metacognitions and negative affect (but not metacognitive strategies) predicted each other the next day, showing a reciprocal relationship. However, metacognitive strategies were significant mediators between metacognitions and negative affect within days and day-to-day. Implications and future directions based on these findings are discussed.

## 1. Introduction

The Self-Regulatory Executive Function (S-REF) model (Wells, 2019; Wells & Matthews, 1994), commonly referred to as the metacognitive model, suggests that psychological disorders are a result of dysfunctional metacognitions and its influence on cognitive and emotional regulation. A key maintenance factor of distress is a set of maladaptive metacognitive strategies named the *Cognitive Attentional Syndrome* (CAS). The CAS consist of perseverative thinking (e.g., worry/rumination), rigid self-attention and threat monitoring, and maladaptive coping behaviours, that initiate, intensify, and maintain emotional distress. The CAS is influenced and directed by the content and procedures of a *metacognitive control system* (Wells, 2019), which among other factors contains metacognitive beliefs about cognition and mental regulation strategies. Positive metacognitive beliefs (e.g., "Rumination will lead to answers") and negative metacognitive beliefs (e.g., "Worrying is uncontrollable"; "Rumination is a sign of weakness") are specifically relevant to understanding how the CAS is activated and maintained in psychological disorders (Wells, 2009). When faced with negative thoughts, feelings, and stressors, individuals holding positive metacognitive beliefs are prone to activate metacognitive strategies such as worry or rumination in response. Further, the activation of these metacognitive strategies interferes with effective cognitive and emotional regulation and evoke negative metacognitive beliefs about the uncontrollability and danger of cognition, which further prevent the individual from applying appropriate cognitive control and in some instances to perceiving cognition itself as threatening ("worrying can damage my brain"), causing prolonged and stronger distress.

As outlined above, the metacognitive model (Wells, 2019) holds the advantage of specifying what is considered the trait and state mechanisms of distress, how these factors are related, and it suggests that metacognitive beliefs and strategies are common determinants of

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https://doi.org/10.1016/j.janxdis.2024.102930
Received 4 October 2023; Received in revised form 19 August 2024; Accepted 13 September 2024
Available online 18 September 2024
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distress. A further advantage is that valid measures of these mechanisms have been developed, providing many opportunities to test the model and thus advance our understanding and the relevance of metacognitive mechanisms (Capobianco & Nordahl, 2023).

Many studies have sought to evaluate the central predictions put forward by the metacognitive model since it was presented in the early 1990s. The cross-sectional relationships between metacognitive beliefs, metacognitive strategies, and symptoms have been reliably established (e.g., Cano-López et al., 2022; Sun et al., 2017). Secondary analyses of treatment studies have consistently reported that metacognitive change correlates with symptom improvement in clinical samples (McEvoy et al., 2015; Nordahl et al., 2017; Solem et al., 2009; Strand et al., 2023). Most prospective studies to date have employed a between-subjects design and indicate that metacognitive beliefs predict symptoms in non-clinical (Capobianco et al., 2019; Nordahl et al., 2022; Nordahl et al., 2023; Papageorgiou & Wells, 2009; Ramos-Cejudo, & Salguero, 2017; Ruiz & Odriozola-González, 2015; Yılmaz et al., 2011) and clinical samples (Faissner et al., 2018; Kraft et al., 2019). At the between-subjects level, dysfunctional metacognitive beliefs are precedents of worry/rumination (i.e., metacognitive strategies) in both non-clinical (Fergus & Wheless, 2018; McEvoy et al., 2013; Thielsch et al., 2015a; Weber & Exner, 2013) and clinical samples (LaFreniere & Newman, 2019; Thielsch et al., 2015b; Wahlund et al., 2021) and metacognitive strategies are prospective predictors of emotional distress symptoms (Ebrahimi et al., 2021, 2022; Hoorelbeke et al., 2019).

Fewer prospective studies have simultaneously taken into consideration the three distinguished levels of the metacognitive model –*metacognitive beliefs*, *metacognitive strategies*, and *emotional distress*– and their differentiation to evaluate their hypothesized temporal order as specified by the model (Wells, 2009). Ryum et al. (2017), over three-time points in a nonclinical sample, and Kraft et al. (2019) over five in a clinical sample, found that metacognitive beliefs and strategies made unique contributions to emotional distress. Thielsch et al. (2015b) found a preceding role for metacognitive beliefs to worry and a reciprocal relationship between worry and sleep problems. Furthermore, Kubiak et al. (2014) and Hallard et al. (2021) found that metacognitive beliefs prospectively predicted metacognitive strategies (rumination and thought control, respectively), which further predicted emotional distress. Most recently, in a four-wave study, Nordahl et al. (2023) found that metacognitive beliefs predicted metacognitive strategies, which in turn predicted anxiety, a finding that supports the notion that metacognitive strategies (partially) mediate the relationship between metacognitive beliefs and anxiety over time.

While these studies have been important in testing the hypothesised three-level structure of the metacognitive model, they are limited by the fact that they have employed between-persons designs. Although this design help to identify patterns and trends that distinguish variations among groups, it cannot address information about how individuals change relative to themselves, which is the level of specificity most relevant to the metacognitive model and other psychotherapy models. Dynamics of change at the *within-person level* transcends daily relations and do not necessarily mirror mechanisms at the *between-person level* (Curran & Bauer, 2011; Curran et al., 2014; Hamaker, 2012; Hamaker & Wichers, 2017).

There are however some studies that have evaluated the metacognitive model looking at the within-person level. In secondary analyses from a randomized controlled trial with complex anxiety patients receiving weekly treatment sessions, Johnson and colleagues reported within-person connections between metacognitive beliefs and metacognitive strategies and that change in these variables influences subsequent emotional distress symptoms (Johnson & Hoffart, 2018); with metacognitive change preceding symptom improvement (Johnson, Hoffart, Nordahl et al., 2018; Hoffart et al., 2018). In patients with obsessive-compulsive symptoms treated with exposure and response prevention, Sunde et al. (2021) found that metacognitive beliefs about the need to control thoughts predicted symptomatology. Recently, Hoffart et al. (2023a) analysed longitudinal within-person relationships of 17 "network items" and reported that negative metacognitive beliefs about cognitive control and threat monitoring (i.e., CAS) were central nodes in a distress network during the COVID-19 pandemic, showing that daily fluctuations in these factors were more predictive of next-day fluctuations in other factors (e.g., anxiety, intolerance of uncertainty).

These studies addressing the within-person level of change represent some of the current and most sophisticated tests of the central predictions derived from the metacognitive model, and particularly those that have been conducted in clinical samples may have important implications for therapeutic settings. However, no study is without limitations and there are gaps in the literature concerning testing the metacognitive model. For example, some of the aforementioned within-person studies have only explored the link between metacognitive beliefs and symptoms (e.g., Sunde et al., 2021; Johnson, Hoffart, Nordahl et al., 2018), tested only a few individual indicators of metacognitive factors (e.g., Johnson & Hoffart, 2018), or not directly tested the (pre-specified) metacognitive model distinguishing between metacognitive beliefs, metacognitive strategies, and emotional distress symptoms (e.g., Hoffart et al., 2023b). Furthermore, studies vary greatly in the time-lag between assessments which in itself is an important factor to consider in testing psychotherapy models as it also relates to differentiating between trait and state influences on symptoms/distress. From a statistical point of view, the mediator should be specified at the timepoint between the dispositional factor and the outcome. From a conceptual and clinical perspective, the time-lag between these factors may be shorter or longer, and is not always easy to test, as mechanisms can assert their effect both in shorter and longer time periods. For example, metacognitive beliefs may activate metacognitive strategies which have a direct impact on symptoms at a particular timepoint (e.g., an individual has the *trigger thought* "what if I have cancer" which is detected by the metacognitive control system containing the positive metacognitive belief that "worrying helps me cope", which will contribute to selecting worrying -a metacognitive strategy- as a coping strategy, which may have an immediate effect on anxiety). In addition, dysfunctional metacognitive beliefs can lead to persistent worry which also makes a negative and different impact on subjective well-being over time (e.g., tired, low mood). Furthermore, metacognitive beliefs may have subtle influences on metacognitive strategies over time (e.g., believing that worrying is uncontrollable and dangerous may maintain an avoidance style -in order to control worrying-, and the effects of avoidance on symptoms may be of more long-term nature). The key point here is that time-lag matters, and that this is further complicated given that metacognitive mechanisms may influence each other and symptoms momentarily and over time.

In the present study, we aimed to add to the previous literature by performing one of the most current and advanced empirical tests of the metacognitive model. By distinguishing and using sound indicators of metacognitive components and a daily diary design, we tested the *within-person dynamic interplay* between metacognitive mechanisms and negative affect to understand how they mutually reinforce each other in their daily evolution within individuals from one day to the next. Furthermore, we were particularly interested in the mediation effect of metacognitive strategies between metacognitive beliefs and negative affect as proposed by the metacognitive model. However, this effect may occur both from day-to-day and within days and we therefore sought to evaluate both alternatives. With these aims, our hypotheses were as follows:

i. Metacognitive beliefs (positive- and negative) will predict next-day negative affect when controlling for previous days' effect from each other and metacognitive strategies, with potential for bidirectional or reciprocal relations.
ii. Metacognitive strategies will mediate the link between metacognitive beliefs (positive- and negative) and negative affect. This

hypothesis was tested both day-to-day and within days to account for time-related specificity in the components influence on each other.

## 2. Methods

### 2.1. Participants and procedure

A total of 222 undergraduate students were recruited (75.2% female, 24.3% male, and 0.5% missing value), ranging from 18 to 62 years old ($M$ = 21.09, $SD$ = 6.65). Participants were gathered at convenience during university lessons. They were asked to take part in a study aiming to evaluate the relationships between cognitive and emotional variables over time. Participants had to be 18 years old or above and be able to read Spanish. Participants were compensated with class credit. They were verbally informed about the study, which was voluntary, anonymous, and confidential. The survey was administrated electronically and completed individually. It was conducted over a 26-day period. Participants were asked to complete the daily assessments each weekday at the same time for four weeks. Ethical approval was obtained from the Complutense University of Madrid (Ref. 2017/18–021).

This study is part of a larger project that investigated the relationship between cognitive factors and depression. Participants of the present study were selected from a larger sample of the project and had medium-low scores on rumination. Likewise, it is worth mentioning that this study was carried out during the COVID-19 health pandemic. The daily measures were collected between April 27th to May 24th, 2020, during the nationwide lockdown in Spain, as the restrictions implemented were from March 14th until June 21st.

### 2.2. Instruments

Positive metacognitive beliefs, negative metacognitive beliefs, and metacognitive strategies were measured with the *Cognitive Attentional Syndrome-1* (CAS-1; Wells, 2009). The CAS-1 is a 16-item self-report questionnaire that was developed to assess metacognitive beliefs and the cognitive attentional syndrome (i.e., metacognitive strategies) in clinical practice. The first two items assess the amount of time spent dwelling on problems (e.g., "Since the last assessment, how much time have you found yourself dwelling on or worrying about your problems?"), the next six items assess the frequency of unhelpful metacognitive strategies to cope with negative thoughts or affect (e.g., "Tried not to think about things", "Asked for reassurance", "Used alcohol/-drugs" or "Controlled my symptoms"); these first eight items are scored on a scale from 0 ("none of the time") to 8 ("all of the time"). The remaining eight items assess negative metacognitive beliefs (e.g., "Worrying too much could harm me") and positive metacognitive beliefs (e.g., "Worrying helps me cope"). Metacognitive belief items are scored on a scale from 0 ("I do not believe this at all") to 100 ("I'm completely convinced this is true"). The CAS-1 subscales have shown good internal consistency in previous literature (Kowalski, & Dragan, 2019; Nordahl & Wells, 2019). In the current study, the internal consistency from the first daily measurement was.76 for metacognitive strategies (Mean = 11.24; $SD$ = 8.59; Skew = 0.56; $S.E$ = 0.04), .79 for negative metacognitive beliefs (Mean = 13.73; $SD$ = 10.15; Skew = 0.40; $S.E$ = 0.04), and .68 for positive metacognitive beliefs (Mean = 17.93; $SD$ = 9.75; Skew = −0.04; $S.E$ = 0.04).

Negative affect was measured with the *Positive and Negative Affect Schedule* (PANAS; Watson et al., 1988). The PANAS is composed of a 20-item self-report scale that evaluates the extent to which 20 emotions can be experienced, 10 items reflect positive affect (PA, e.g., "excited") and the remaining 10 reflect negative affect (NA, e.g., "distressed"). In the current research, we only used the NA subscale, since negative affect is more strongly associated with depression, anxiety, and psychological dysfunction. Participants were asked to rate items from 1 ("Not at all") to 5 ("Extremely"), scoring their extent of negative affect since the last assessment, every day. The PANAS has shown good psychometric properties, being a reliable and valid measure (López-Gómez et al., 2015; Sandín et al., 1999; Tuccitto et al., 2010). In the current study, the internal consistency for NA from the first daily measurement was .88 (Mean = 17.40; $SD$ = 7.23; Skew = 1.27; $S.E$ = 0.04).

### 2.3. Statistical analyses

Preliminary checks showed missing data progressively increased for all variables across measurement occasions ranging from 9.46% one day to a highest of 20.70% on the final day. All available data were used in the analyses under the assumption that data were missing at random. The Dynamic Structural Equation Modelling (DSEM) framework was used to create a trivariate multilevel cross-lagged model to examine the dynamic interplay between metacognitive beliefs, metacognitive strategies, and negative affect. Analyses were performed in Mplus 8.9 (Muthén & Muthén, 1998–, 2023). The DSEM framework (Hamaker et al., 2017; Hamaker et al., 2018), enables the modelling of the lagged relation of several repeated observations (time-series analysis) of multiple individuals while allowing for individual differences (multilevel modelling) with latent variables (structural equation modelling). DSEM combines the time-series model at Level 1 which describes the *within--person dynamic interplay*, and a Level 2 model which describes the *between-person* part of the model (Hamaker et al., 2017; Hamaker et al., 2018; McNeish & Hamaker, 2020).

The variables are decomposed into latent *within-* and *between-person* components and lagged to control and estimate the prediction of daily observations on next day's outcomes using the multilevel vector autoregressive model with lag-1 (i.e., Multilevel VAR (1) Model). In the DSEM, 50000 iterations of the MCMC algorithm were run and a thinning of 10 was used. We checked the proportional scale reduction and trace plots for the absence of trends, spikes or any irregularities for model convergence (Hamaker et al., 2018). Missing values were added for weekends to create equidistant observations. The effect of time was included at the within-person level model as a predictor to ensure stationarity.

To respond to hypothesis one, the daily effect of each variable was allowed to predict itself the next day. In the first analyses, negative metacognitive beliefs at time, $t$ was regressed on negative metacognitive beliefs at time, $t$-1; $\Phi_{_NN}$, metacognitive strategies at time, $t$ was regressed on metacognitive strategies at time, $t$-1; $\Phi_{_CC}$, and negative affect at time, $t$ was regressed on negative affect at time, $t$-1; $\Phi_{_AA}$. These autoregressive parameters (e.g., $\Phi_{_NN}$) indicate carryover effects. Autoregressive values close to 'zero' imply a strong attraction dynamic whereby after a high or low score, an individual will quickly recover to their baseline (e.g., typical level of negative metacognitive beliefs). Autoregressive values closer to 1 imply more carryover from one day to the next day such that, for example, an individual with high negative metacognitive beliefs autoregressive value would be likely to have several consecutive days in a row with high or low negative metacognitive beliefs above or below their baseline/equilibrium – reflecting regulatory weakness. In addition, negative metacognitive beliefs at time, $t$, was regressed on metacognitive strategies at time, $t$-1; $\beta_{_NC}$, and negative affect at time, $t$-1; $\beta_{_NA}$. Metacognitive strategies at time, $t$, was regressed on negative metacognitive beliefs at time, $t$-1; $\beta_{_CN}$ and negative affect at time, $t$-1; $\beta_{_CA}$. Finally, negative affect at time, $t$, was regressed on negative metacognitive beliefs at time, $t$-1; $\beta_{_AN}$, and metacognitive strategies at time, $t$-1; $\beta_{_SC}$. These cross-lagged parameters (e.g., $\beta_{_NC}$) indicate spill-over effect of one domain into another domain, thus representing potential causal and dynamic interplay between variables at the *within-person level model* (see Fig. 1). In the second analyses, we estimated the same model parameters only replacing negative metacognitive beliefs with positive metacognitive beliefs, everything else remained the same.

To respond to hypothesis two, we first estimated a two-level time-series mediation model in the DSEM framework (McNeish & MacKinnon, 2022) for intensive longitudinal data. Lagged relationships

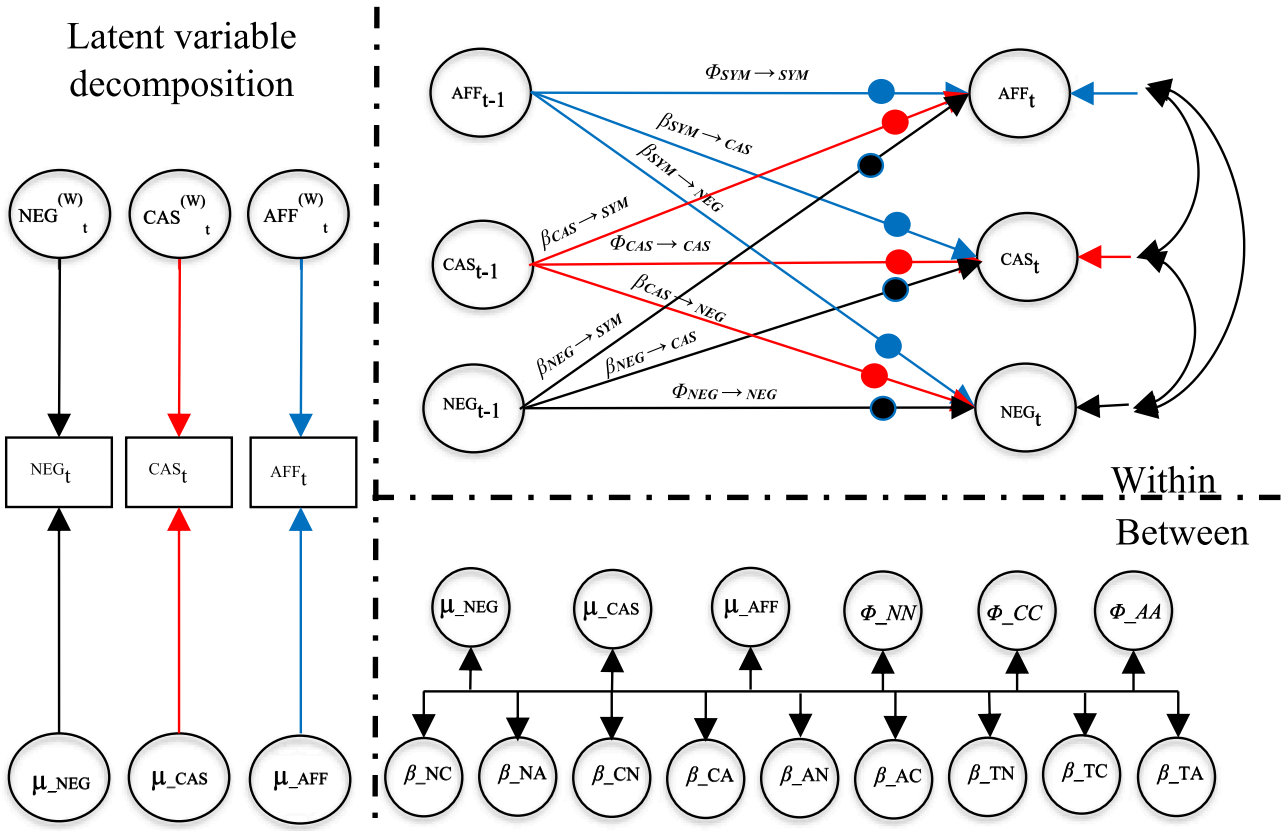



**Fig. 1.** Multilevel vector auto regressive model with lag-1 showing bidirectional relationship between negative metacognitive beliefs (NEG), metacognitive strategies (CAS), and negative affect (AFF). Time as predictor is omitted to reduce clutter.

among the variables were created to correspond to the lag effect of metacognitive beliefs from both one and two days prior, and the lag effect of metacognitive strategies and negative affect from the previous day. Autoregressive parameters were estimated for all variables, and the mediator (metacognitive strategies) intervened in time between the predictor (metacognitive beliefs) and the outcome (negative affect).

For the mediation, the effect of daily metacognitive beliefs (i. negative, ii. positive) on next day metacognitive strategies represents *a-path*, and the effect of daily metacognitive strategies on next day negative affect represent *b-path*. The conditional direct effect of negative metacognitive beliefs two days prior on negative affect represents the *c'-path* (see Fig. 3). Between-person heterogeneity was taken into account in the mediated paths since this affords realistic conceptualization of *within-person* psychological processes in the DSEM framework, and the covariance between the random effect of the *a-path* and *b-path* were freely estimated (see McNeish & MacKinnon, 2022 for intensive longitudinal mediation tutorial).

In follow-up analyses, we also tested a *within-day* mediation model in which the effect of metacognitive beliefs on metacognitive strategies (i.e., *a-path*), and the effect of metacognitive strategies on negative affect (*b-path*), as well as the direct effect of metacognitive beliefs on negative affect (*c'-path)*, all occurred within each day. Our aim here was to test the within-person daily relations among metacognitive beliefs, metacognitive strategies, and negative affect as metacognitive factors is likely to impact on symptoms both over time and at a particular time point, as outlined in the introduction.

## 3. Results

### 3.1. Dynamic interplay in the connections between dysfunctional metacognitive beliefs, metacognitive strategies, and negative affect

Results from the Multilevel VAR (1) model of i) negative metacognitive beliefs, metacognitive strategies, and negative affect, and ii) positive metacognitive beliefs, metacognitive strategies, and negative affect are displayed in Tables 1 and 2, respectively, with their corresponding path diagram in Fig. 2 (a and b). The Multilevel VAR (1) model provides average carryover effects in the population, as well as for individuals (i.e., *within-person level model*) in the sample. We consider the standardized results to interpret the magnitude of the cross-lagged effects capturing the dynamic interplay of dysfunctional metacognitive beliefs, metacognitive strategies, and negative affect operating *within individuals*. These standardized effects are based on recommendations (Schuurman et al., 2016) in multilevel models, and can be used to compare the relative strength of cross-lagged effect to answer the question *"does dysfunctional metacognitive beliefs predict metacognitive strategies or negative affect the next day stronger than the reverse?"*.

### 3.2. Negative metacognitive beliefs, metacognitive strategies, and negative affect

The model explained 30.6% of within-person variability in negative metacognitive beliefs, 31.6% in metacognitive strategies, and 27.5% in negative affect. The size of the autoregressive parameter for negative affect was stronger ($\Phi_{_AA}$ =.28 [0.23 – 0.33]) than negative metacognitive beliefs ($\Phi_{_NN}$ =.18 [0.13 – 0.24]) and metacognitive strategies ($\Phi_{_CC}$ =.18 [0.13 – 0.24]). The autoregressive parameters were significant and positive, indicating low carryover effect such that after a day of more or less negative metacognitive beliefs, metacognitive strategies, or

**Table 1**
Parameter estimates in the Multilevel VAR (1) Model for Negative metacognitive beliefs, Metacognitive strategies, and Negative affect.

| Variables | | | | |
|---|---|---|---|---|
| **Means** | Notation | Estimate | Posterior SD | 95% Credible Interval |
| Negative metacognitive beliefs | $\mu_{NEG}$ | 13.14 * | 0.71 | 11.750 – 13.581 |
| CAS strategies | $\mu_{CAS}$ | 12.44 * | 0.56 | 11.314 – 13.581 |
| Negative affect | $\mu_{AFF}$ | 18.07 * | 0.50 | 17.091 – 19.062 |
| **Autoregressions** | | | | |
| Negative metacognitive beliefs → Negative metacognitive beliefs | $\Phi_{NN}$ | 0.18 * | 0.03 | 0.131 – 0.233 |
| CAS strategies → CAS strategies | $\Phi_{CC}$ | 0.18 * | 0.03 | 0.126 – 0.239 |
| Negative affect → Negative affect | $\Phi_{AA}$ | 0.28 * | 0.03 | 0.230 – 0.333 |
| **Cross-lagged effects** | | | | |
| Negative metacognitive beliefs → CAS strategies | $\beta_{CN}$ | 0.11 * | 0.03 | 0.054 – 0.163 |
| Negative metacognitive beliefs → Negative affect | $\beta_{AN}$ | 0.08 * | 0.03 | 0.026 – 0.132 |
| CAS strategies → Negative metacognitive beliefs | $\beta_{NC}$ | 0.03 | 0.03 | −0.026 – 0.077 |
| CAS strategies → Negative affect | $\beta_{AC}$ | 0.00 | 0.03 | −0.051 – 0.047 |
| Negative affect → CAS strategies | $\beta_{CA}$ | 0.07 * | 0.03 | 0.019 – 0.128 |
| Negative affect → Negative metacognitive beliefs | $\beta_{NA}$ | 0.06 * | 0.03 | 0.010 – 0.113 |
| **Variances** | | | | |
| Negative metacognitive beliefs | $\Psi_{\mu NEG}$ | 91.88 * | 11.08 | 73.265 – 116.805 |
| CAS strategies | $\Psi_{\mu CAS}$ | 54.31 * | 7.12 | 42.022 – 70.018 |
| Negative affect | $\Psi_{\mu AFF}$ | 36.29 * | 5.65 | 26.665 – 48.643 |
| Negative metacognitive beliefs → Negative metacognitive beliefs | $\Psi_{\Phi NN}$ | 0.07 * | 0.02 | 0.047 – 0.106 |
| CAS strategies → CAS strategies | $\Psi_{\Phi CC}$ | 0.05 * | 0.01 | 0.031 – 0.086 |
| Negative affect → Negative affect | $\Psi_{\Phi AA}$ | 0.09 * | 0.02 | 0.058 – 0.127 |
| Negative metacognitive beliefs → CAS strategies | $\Psi_{\beta CN}$ | 0.10 * | 0.03 | 0.051 – 0.160 |
| Negative metacognitive beliefs → Negative affect | $\Psi_{\beta AN}$ | 0.06 * | 0.02 | 0.031 – 0.110 |
| CAS strategies → Negative metacognitive beliefs | $\Psi_{\beta NC}$ | 0.06 * | 0.02 | 0.038 – 0.099 |
| CAS strategies → Negative affect | $\Psi_{\beta AC}$ | 0.04 * | 0.01 | 0.018 – 0.063 |
| Negative affect → CAS strategies | $\Psi_{\beta CA}$ | 0.09 * | 0.02 | 0.050 – 0.136 |
| Negative affect → Negative metacognitive beliefs | $\Psi_{\beta NA}$ | 0.07 * | 0.02 | 0.041 – 0.105 |

*Note*: *Significance is based on the Credible Interval not containing zero. NEG or N = Negative metacognitive beliefs; CAS or C = Metacognitive strategies; AFF or A = Negative affect

**Table 2**
Parameter estimates in the Multilevel VAR (1) Model for Positive metacognitive beliefs, Metacognitive strategies, and Negative affect.

| Variables | | | | |
|---|---|---|---|---|
| **Means** | Notation | Estimate | Posterior SD | 95% Credible Interval |
| Positive metacognitive beliefs | $\mu_{POS}$ | 18.06 * | 0.68 | 16.724 – 19.409 |
| CAS strategies | $\mu_{CAS}$ | 12.54 * | 0.58 | 11.391 – 13.696 |
| Negative affect | $\mu_{AFF}$ | 18.19 * | 0.52 | 17.189 – 19.230 |
| **Autoregressions** | | | | |
| Positive metacognitive beliefs → Positive metacognitive beliefs | $\Phi_{PP}$ | 0.18 * | 0.02 | 0.134 – 0.231 |
| CAS strategies → CAS strategies | $\Phi_{CC}$ | 0.20 * | 0.03 | 0.149 – 0.254 |
| Negative affect → Negative affect | $\Phi_{AA}$ | 0.29 * | 0.03 | 0.236 – 0.340 |
| **Cross-lagged effects** | | | | |
| Positive metacognitive beliefs → CAS strategies | $\beta_{CP}$ | 0.02 | 0.03 | −0.030 – 0.066 |
| Positive metacognitive beliefs → Negative affect | $\beta_{AP}$ | 0.06 * | 0.02 | 0.016 – 0.115 |
| CAS strategies → Positive metacognitive beliefs | $\beta_{PC}$ | −0.01 | 0.03 | −0.060 – 0.047 |
| CAS strategies → Negative affect | $\beta_{AC}$ | −0.01 | 0.03 | −0.058 – 0.041 |
| Negative affect → CAS strategies | $\beta_{CA}$ | 0.09 * | 0.03 | 0.031 – 0.144 |
| Negative affect → Positive metacognitive beliefs | $\beta_{PA}$ | 0.07 * | 0.03 | 0.015 – 0.116 |
| **Variances** | | | | |
| Positive metacognitive beliefs | $\Psi_{\mu POS}$ | 79.80 * | 7.07 | 63.583 – 101.103 |
| CAS strategies | $\Psi_{\mu CAS}$ | 54.01 * | 7.07 | 41.832 – 69.624 |
| Negative affect | $\Psi_{\mu AFF}$ | 37.73 * | 5.84 | 27.907 – 50.447 |
| Positive metacognitive beliefs → Positive metacognitive beliefs | $\Psi_{\Phi PP}$ | 0.07 * | 0.02 | 0.049 – 0.106 |
| CAS strategies → CAS strategies | $\Psi_{\Phi CC}$ | 0.07 * | 0.02 | 0.039 – 0.100 |
| Negative affect → Negative affect | $\Psi_{\Phi AA}$ | 0.09 * | 0.02 | 0.056 – 0.122 |
| Positive metacognitive beliefs → CAS strategies | $\Psi_{\beta CP}$ | 0.08 * | 0.02 | 0.040 – 0.127 |
| Positive metacognitive beliefs → Negative affect | $\Psi_{\beta AP}$ | 0.04 * | 0.01 | 0.020 – 0.078 |
| CAS strategies → Positive metacognitive beliefs | $\Psi_{\beta PC}$ | 0.08 * | 0.02 | 0.053 – 0.123 |
| CAS strategies → Negative affect | $\Psi_{\beta AC}$ | 0.06 * | 0.01 | 0.025 – 0.075 |
| Negative affect → CAS strategies | $\Psi_{\beta CA}$ | 0.08 * | 0.02 | 0.044 – 0.125 |
| Negative affect → Positive metacognitive beliefs | $\Psi_{\beta PA}$ | 0.04 * | 0.01 | 0.021 – 0.069 |

*Note*: *Significance is based on the Credible Interval not containing zero. POS or P = Negative metacognitive beliefs; CAS or C = Metacognitive strategies; AFF or A = Negative affect

negative affect than is typical, an individual will return relatively quickly to their baseline on the following day.

Daily negative metacognitive beliefs predicted next-day metacognitive strategies ($\beta = .11$ [0.05, 0.16]) and negative affect ($\beta = .08$ [0.03, 0.13]). Daily negative affect predicted next day negative metacognitive beliefs ($\beta = .06$ [0.01, 0.11]) and metacognitive strategies ($\beta = .07$ [0.02, 0.13]). However, daily metacognitive strategies neither predicted the next day negative metacognitive beliefs ($\beta = .03$ [−0.03, 0.08]) nor negative affect ($\beta = .00$ [−0.05, 0.05]).

### *3.3. Positive metacognitive beliefs, metacognitive strategies, and negative affect*

The model explained 32.1% of within-person variability in positive metacognitive beliefs, 30.3% in metacognitive strategies, and 26.5% in negative affect. The size of the autoregressive parameter for negative affect was stronger ($\Phi_{_AA}$ =.29 [0.24 – 0.34]) than metacognitive strategies ($\Phi_{_CC}$ =.20 [0.15 – 0.25]) and positive metacognitive beliefs ($\Phi_{_PP}$ =.18 [0.13 – 0.23]). The autoregressive parameters indicated a low carryover effect with individuals returning relatively quickly to their baseline on the following day.

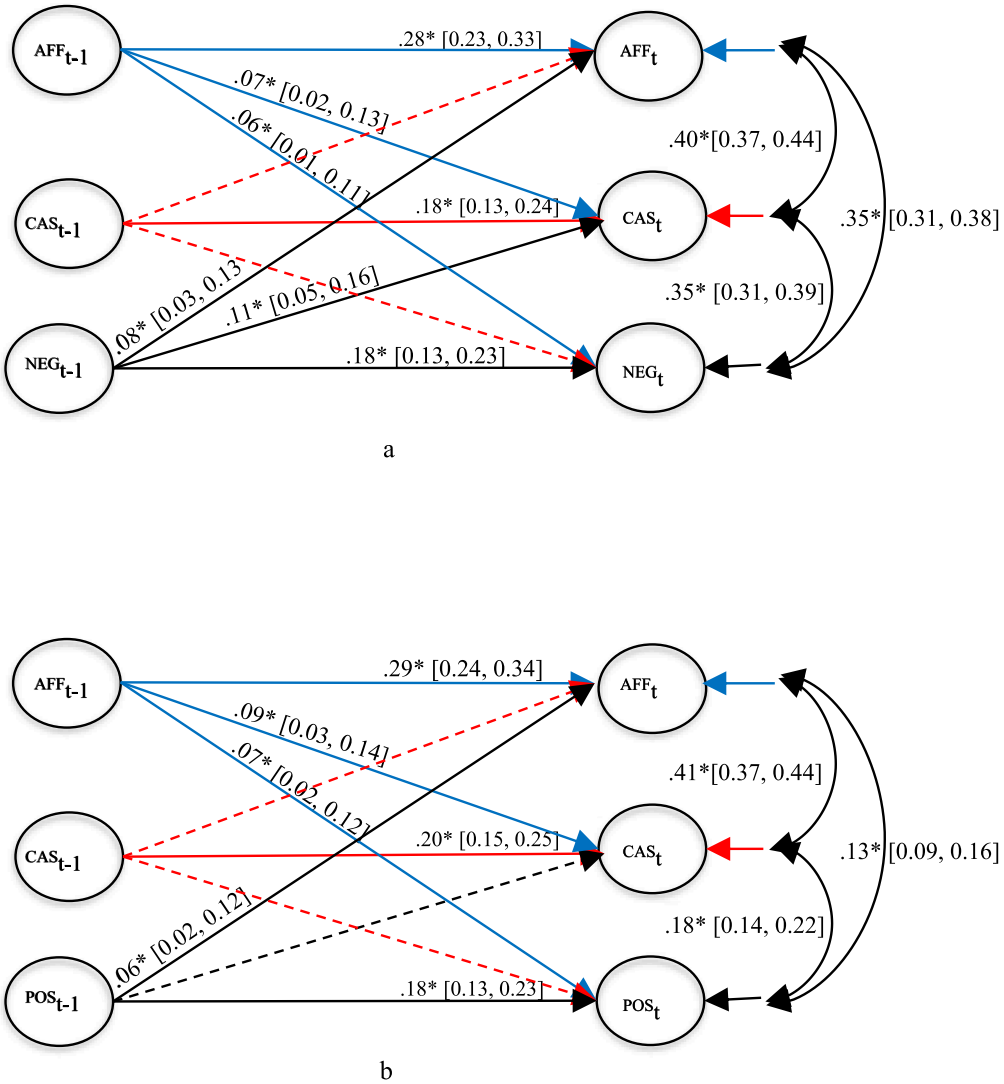



**Fig. 2.** a: Within-person auto regressive cross-lagged model for negative metacognitive beliefs (NEG), metacognitive strategies (CAS), and negative affect (AFF). Non-significant effects shown in broken lines. *Note:* *Significance is based on the Credible interval not containing zero. b: Within-person auto regressive cross-lagged model for positive metacognitive beliefs (POS), metacognitive strategies (CAS), and negative affect (AFF). Non-significant effects shown in broken lines. *Note:* *Significance is based on the Credible interval not containing zero.

Daily positive metacognitive beliefs predicted next day negative affect ($\beta = .06$ [0.02, 0.12]), but not metacognitive strategies ($\beta = .02$ [−0.03, 0.07]). Daily negative affect predicted next day positive metacognitive beliefs ($\beta = .07$ [0.02, 0.12]) and metacognitive strategies ($\beta = .09$ [0.03, 0.14]). However, daily metacognitive strategies neither predicted next day positive metacognitive beliefs ($\beta = -.01$ [−0.06, 0.05]) nor negative affect ($\beta = -.01$ [−0.06, 0.04]).

### 3.4. The mediational effect of metacognitive strategies in the relation between metacognitive beliefs and negative affect

#### 3.4.1. Day-to-day mediation effect by metacognitive strategies in the relation between negative metacognitive beliefs and negative affect

The model explained 17.8% of within-person variability in negative metacognitive beliefs, 22.5% in metacognitive strategies, and 19.9% in negative affect. Daily negative metacognitive beliefs significantly predicted next day metacognitive strategies (*a-path* = 0.11 [0.060, 0.153]). However, daily metacognitive strategies did not significantly predict next day negative affect (*b-path* = 0.04 [0.28, 0.36]) when controlling for negative metacognitive beliefs two days prior on negative affect (*c'-path* = 0.00 [−0.054, 0.055]). The indirect effect through metacognitive strategies was significant (*a*-path***b*-path + cov:*ab* = 0.02 [0.010, 0.036]) (see Table 3 and Fig. 3a).

#### 3.4.2. Day-to-day mediation effect by metacognitive strategies in the relation between positive metacognitive beliefs and negative affect

The model explained 18.7% of within-person variability in positive metacognitive beliefs, 23.0% in metacognitive strategies, and 19.9% in negative affect. Daily positive metacognitive beliefs did not significantly predict metacognitive strategies (*a-path* = 0.05 [0.000, 0.0105]). Daily metacognitive strategies significantly predicted next day negative affect (*b-path* = 0.05 [0.004, 0.099]), when controlling for positive metacognitive beliefs two days prior on negative affect (*c'-path* = −0.04 [−0.097, 0.013]). The indirect effect through metacognitive strategies was significant (*a*-path***b*-path + cov:*ab* = 0.01 [0.002, 0.026]) (see Table 4 Fig. 3b).

#### 3.4.3. Within-day mediation effect by metacognitive strategies in the relation between metacognitive beliefs and negative affect

To evaluate the hypothesised relations between metacognitive beliefs, metacognitive strategies, and negative affect at a given time point, we also tested a *within-day* mediation model in which the effect of

**Table 3**
Results from Person-Specific Mediation Model with Between-Person Variance in all Mediation Paths for Negative metacognitive beliefs, Metacognitive strategies, and Negative affect.

| Variables | | | | |
|---|---|---|---|---|
| **Means** | Notation | Estimate | Posterior SD | 95% Credible Interval |
| Negative metacognitive beliefs | $\mu_{_NEG}$ | 13.33 | 0.63 * | 12.084 – 14.565 |
| CAS strategies | $\mu_{_CAS}$ | 12.74 | 0.50 * | 11.746 – 13.700 |
| Negative affect | $\mu_{_AFF}$ | 18.43 | 0.43 * | 17.576 – 19.266 |
| **Autoregressions** | | | | |
| Negative metacognitive beliefs → Negative metacognitive beliefs | $\Phi_{_NN}$ | 0.24 | 0.02 * | 0.201 – 0.282 |
| CAS strategies → CAS strategies | $\Phi_{_CC}$ | 0.32 | 0.02 * | 0.269 – 0.363 |
| Negative affect → Negative affect | $\Phi_{_AA}$ | 0.34 | 0.02 * | 0.287 – 0.381 |
| **Mediation paths** | | | | |
| Negative metacognitive beliefs → CAS strategies | *a*-path | 0.11 | 0.02 * | 0.060 – 0.153 |
| CAS strategies → Negative affect | *b*-path | 0.04 | 0.02 | −0.008 – 0.083 |
| Negative metacognitive beliefs$_{t-2}$ → Negative affect | *c'*-path | 0.00 | 0.03 | −0.054 – 0.055 |
| Fixed indirect effect (mediation) | *a*-path**b*-path + $\Psi_{_}$ *a*-path, *b*-path | 0.02 | 0.01 * | 0.010 – 0.036 |
| **Variances** | | | | |
| Negative metacognitive beliefs | $\Psi_{_\mu_{NEG}}$ | 76.78 | 8.09 * | 62.628 – 94.152 |
| CAS strategies | $\Psi_{_\mu_{CAS}}$ | 43.10 | 4.93 * | 34.822 – 54.168 |
| Negative affect | $\Psi_{_\mu_{AFF}}$ | 27.49 | 3.31 * | 22.176 – 35.073 |
| *a*-path fixed effect | $\Psi_{_}$ *a*-path | 0.02 | 0.01 * | 0.003 – 0.039 |
| *b*-path fixed effect | $\Psi_{_}$ *b*-path | 0.03 | 0.01 * | 0.013 – 0.044 |
| *c'*-path fixed effect | $\Psi_{_}$ *c'*-path | 0.03 | 0.01 * | 0.008 – 0.061 |
| *a*-path, *b*-path covariance | $\Psi_{_}$ *a*-path, *b*-path | 0.02 | 0.01 * | 0.007 – 0.031 |

*Note*: *Significance is based on the Credible Interval not containing zero. NEG or N = Negative metacognitive beliefs; CAS or C = Metacognitive strategies; AFF or A = Negative affect

metacognitive beliefs on metacognitive strategies (i.e., *a-path*), and the effect of metacognitive strategies on negative affect (*b-path*), as well as the direct effect of metacognitive beliefs on negative affect (*c'-path)* (see Fig. 4), all occurred within each day.

For the model with negative metacognitive beliefs (Figs. 4a), 16.3% of within-person variability was explained in metacognitive strategies and 28.3% in negative affect. Within each day, negative metacognitive beliefs significantly predicted metacognitive strategies (*a-path* = 0.39 [0.325, 0.456]), metacognitive strategies in turn significantly predicted negative affect (*b-path* = 0.32 [0.263, 0.371]) when controlling for negative metacognitive beliefs on negative affect (*c'-path* = 0.26 [0.197, 0.316]) (Fig. 4a). The indirect effect through metacognitive strategies was significant (*a*-path**b*-path + cov:*ab* = 0.14 [0.101, 0.178]).

For the model with positive metacognitive beliefs (Figs. 4b), 13.7% of within-person variability was explained in metacognitive strategies and 25.3% in negative affect. Within each day, positive metacognitive beliefs significantly predicted metacognitive strategies (*a-path* = 0.27 [0.200, 0.330]), metacognitive strategies in turn significantly predicted negative affect (*b-path* = 0.38 [0.318, 0.432]) when controlling for positive metacognitive beliefs on negative affect (*c'-path* = 0.04 [−0.010, 0.096]) (Fig. 4b). The indirect effect through metacognitive strategies was significant (*a*-path**b*-path + cov:*ab* = 0.09 [0.052, 0.128]).

Overall, metacognitive strategies mediate the effect that positive and negative metacognitive beliefs have on negative affect *day-to-day* and *within* days. Additionally, when controlling for the effect of daily metacognitive strategies on next day negative affect, neither positive nor negative metacognitive beliefs two days prior predicted negative affect. When controlling for the effect of metacognitive strategies on negative affect within each day, negative metacognitive beliefs but not positive metacognitive beliefs significantly predicted negative affect. Furthermore, negative metacognitive beliefs but not positive metacognitive beliefs significantly predicted negative affect over metacognitive strategies within each day.

#### *3.4.4. Alternative tests of day-to-day mediation effect by metacognitive beliefs*

Following a reviewer suggestion, and to gain further support for our hypotheses, we tested an alternative model not consistent with metacognitive theory (Wells, 2019) in which metacognitive beliefs was a mediator of the relationship between metacognitive strategies and negative affect. We focused on the day-to-day model as it responds more directly to the question of mechanism of action (see Cole & Maxwell, 2003; Hayes, 2009; Selig & Preacher, 2009). Results showed that day-to-day metacognitive beliefs (both negative and positive in separate models) were not a significant mediator of the relationship.

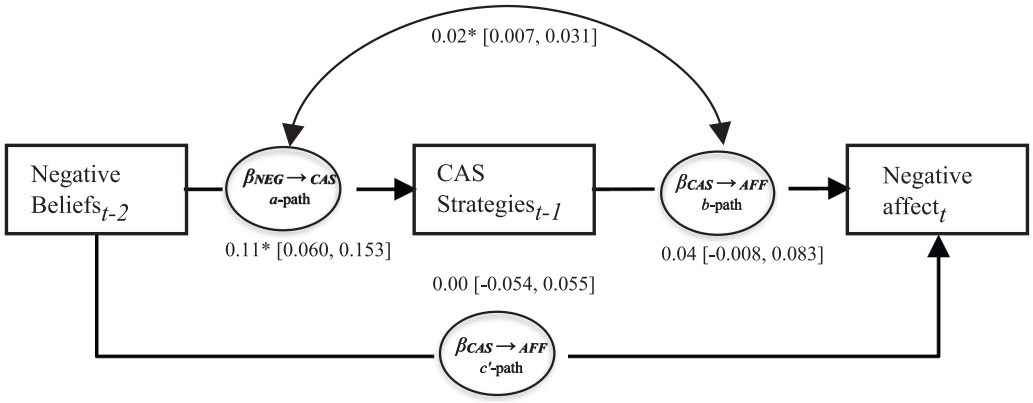
## 4. Discussion

The main aim of this study was to test the principal tenets proposed by the metacognitive model regarding how metacognitive factors and negative affect influence each other in their daily evolution *within individuals*. We examined the within-person dynamic interplay in the lagged connections between (negative and positive) metacognitive beliefs, metacognitive strategies, and negative affect, from previous day to next day, and the contribution of metacognitive strategies in the link between metacognitive beliefs and negative affect *from day to day* and *within days*.

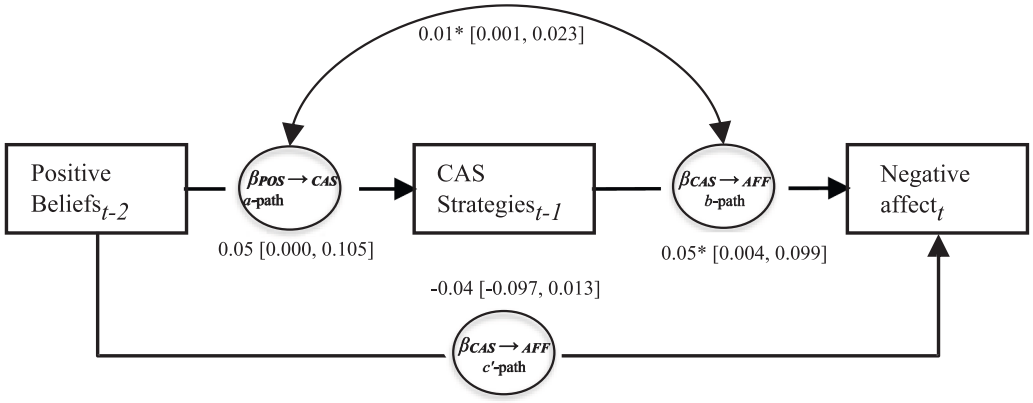
In line with our first hypothesis, we found that both negative and positive metacognitive beliefs predicted the next day's negative affect when controlling for previous days' effects of metacognitions, metacognitive strategies, and negative affect. Here, the relationships between dysfunctional metacognitive beliefs and negative affect were reciprocal. Daily negative- but not positive metacognitive beliefs predicted next day metacognitive strategies when controlling for previous days' effects of assessed factors. Finally, daily negative affect predicted next-day metacognitive strategies when controlling the other factors, but daily metacognitive strategies did not predict next-day negative affect nor metacognitive beliefs.

We further evaluated the three-level structure of the metacognitive model with a particular aim to evaluate the mediational role of metacognitive strategies in the relations between metacognitive beliefs and negative affect. Metacognitive belief domains were tested in separate models. Day-to-day, negative- but not positive metacognitive beliefs predicted next day metacognitive strategies. Daily metacognitive strategies predicted next day negative affect when controlling previous day positive- but not negative metacognitive beliefs. Here, we also tested an alternative model where metacognitive beliefs were used as the mediator in the relationship between metacognitive strategies and negative affect. As this model is not consistent with the metacognitive theory (Wells, 2019) it served as a comparator and the finding that neither positive- nor negative metacognitive beliefs served as a mediator further validates the theoretically consistent model.

Within days, positive- and negative metacognitive beliefs predicted metacognitive strategies which further predicted negative affect when controlling for the direct effect of metacognitions on negative affect.




a




b

**Fig. 3.** a: Day-to-day within-person mediation model for negative metacognitive beliefs (NEG), metacognitive strategies (CAS), and negative affect (AFF). b: Day-to-day within-person mediation model for positive metacognitive beliefs (POS), metacognitive strategies (CAS), and negative affect (AFF).

These findings bring support to our second hypothesis and a mediational role for the CAS in the relation between metacognitive beliefs and negative affect and also suggests that the CAS has independent effect on negative affect that is most pronounced within days when taking metacognitive beliefs into account.

Metacognitive strategies mediated the relations between metacognitive beliefs and negative affect within days and seems to exert a more proximal and stronger influence on negative affect compared to metacognitions. Day-to-day, the mediational role of metacognitive strategies emerged as more complex as negative metacognitive beliefs predicted next day metacognitive strategies but were found to have the more unique impact on negative affect at a later time point. Furthermore, positive metacognitive beliefs did not significantly predict next day metacognitive strategies, but in this model, metacognitive strategies significantly predicted later negative affect. These results are consistent with a dynamic interplay between emotional distress and metacognitions. They bring support to some of the central predictions put forward by the metacognitive model (Wells, 2009, 2019) such as i) negative metacognitive beliefs may be a core etiological and maintenance factor of emotional distress, ii) positive metacognitive beliefs are more related to momentary strategy selection, and that metacognitive strategies are more proximal influences on emotional distress compared to metacognitive beliefs. We further found support for a mediational role of metacognitive strategies in the relationship between metacognitive beliefs and emotional distress, and that this effect was more broadly observed closer in time (i.e., more within days than day-to-day). Note that these interpretations must be taken with caution as specificity of indicators may impact on the results, we were unable to test the role of positive- and negative metacognitive beliefs in the same model, and there is also the option that different time lags between assessment points may affect the within-person patterns.

Our study adds to previous studies reporting on within-person relations. For example, both Sunde et al. (2021), in a weekly intervention for 12 weeks, and Johnson, Hoffart, Nordahl et al. (2018) in an 8-week intervention, found reciprocal relations at the within-person level between negative metacognitive beliefs and symptoms, but they did not evaluate the potential mediational role of metacognitive strategies. Moreover, studies that have used network methodology have taken an exploratory approach and investigated only a few items of metacognitive nature. However, they have also reported that negative metacognitive beliefs predict next-day metacognitive strategies and negative affect, that negative metacognitive beliefs are more important in comparison to positive metacognitive beliefs and have also found bidirectional links between symptoms and metacognitions at the within-person level (Hoffart et al., 2023a; Johnson & Hoffart, 2018). Ebrahimi and colleagues (2021), in a 40-day daily diary study, found a significant predictive forward link between rumination (i.e., metacognitive strategy) and next day negative affect, but did not control for

**Table 4**
Results from Person-Specific Mediation Model with Between-Person Variance in all Mediation Paths for Positive metacognitive beliefs, Metacognitive strategies, and Negative affect.

| Variables | | | | |
|---|---|---|---|---|
| **Means** | Notation | Estimate | Posterior SD | 95% Credible Interval |
| Positive metacognitive beliefs | $\mu_{_POS}$ | 18.20 * | 0.58 | 17.051 – 19.338 |
| CAS strategies | $\mu_{_CAS}$ | 12.74 * | 0.51 | 11.744 – 13.702 |
| Negative affect | $\mu_{_AFF}$ | 18.45 * | 0.43 | 17.594 – 19.291 |
| **Autoregressions** | | | | |
| Positive metacognitive beliefs → Positive metacognitive beliefs | $\Phi_{_PP}$ | 0.22 * | 0.02 | 0.172 – 0.256 |
| CAS strategies → CAS strategies | $\Phi_{_CC}$ | 0.35 * | 0.02 | 0.302 – 0.395 |
| Negative affect → Negative affect | $\Phi_{_AA}$ | 0.34 * | 0.03 | 0.286 – 0.381 |
| **Mediation paths** | | | | |
| Positive metacognitive beliefs → CAS strategies | *a*-path | 0.05 | 0.03 | 0.000 – 0.105 |
| CAS strategies → Negative affect | *b*-path | 0.05 * | 0.02 | 0.004 – 0.099 |
| Positive metacognitive beliefs → Negative affect | *c'*-path | −0.04 | 0.03 | −0.097 – 0.013 |
| Fixed indirect effect (mediation) | *a*-path**b*-path + $\Psi_{_}$ *a*-path, *b*-path | 0.01 * | 0.01 | 0.002 – 0.026 |
| **Variances** | | | | |
| Positive metacognitive beliefs | $\Psi_{_}\mu_{NEG}$ | 65.53 * | 6.91 | 53.165 – 80.194 |
| CAS strategies | $\Psi_{_}\mu_{CAS}$ | 42.82 * | 4.93 | 34.524 – 53.783 |
| Negative affect | $\Psi_{_}\mu_{AFF}$ | 27.74 * | 3.35 | 22.299 – 35.342 |
| *a*-path fixed effect | $\Psi_{_}$ *a*-path | 0.02 * | 0.01 | 0.002 – 0.048 |
| *b*-path fixed effect | $\Psi_{_}$ *b*-path | 0.02 * | 0.01 | 0.010 – 0.041 |
| *c'*-path fixed effect | $\Psi_{_}$ *c'*-path | 0.03 * | 0.02 | 0.006 – 0.080 |
| *a*-path, *b*-path covariance | $\Psi_{_}$ *a*-path, *b*-path | 0.01 * | 0.01 | 0.001 – 0.023 |

*Note*: *Significance is based on the Credible Interval not containing zero. POS or P = Negative metacognitive beliefs; CAS or C = Metacognitive strategies; AFF or A = Negative affect

the influence of metacognitive beliefs.

As we used a convenience sample, our results may not generalize to clinical samples and psychotherapy. However, our results speak to relations and change within individuals, and adds to the collection of a few studies with a similar design and level of analysis. Finding support for the hypothesized relations between metacognitive beliefs and negative affect within individuals at least suggest that further studies should investigate these relations in clinical samples. Our results further suggests that the CAS is more relevant as a within-day mediator in the relationship between metacognitive beliefs and negative affect, but further studies should replicate this finding as the operationalization and nature of metacognitive strategies might have impacted on these findings. If our results are to replicate in clinical samples, we can address questions concerning how to bring about therapeutic change through metacognitive mechanisms.

Founded on the metacognitive model, Metacognitive Therapy (MCT; Wells, 2009) was specifically developed to bring metacognitive change and has proven to be highly effective treatment for emotional disorders (Normann & Morina, 2018), and there is some evidence suggesting that it can be a better treatment for anxiety and depression compared to other recommended treatment options (Callesen et al., 2020; Nordahl et al., 2018; Solem et al., 2021). One explanation is that MCT directly and specifically address metacognitive beliefs and metacognitive strategies which according to the present study are important interconnected factors contributing to negative affect. In addition, our results indicate that improving negative affect is likely to improve dysfunctional metacognitions. We cannot based on our approach fully determine if negative affect or metacognitions are the more influential factor over time. However, as suggested by the metacognitive model, we found support for a role for metacognitions in its relationship with negative affect over time and one advantage of formulating metacognitions as a central influence is that it provides specific and solid directions for how improvement in the interplay between negative affect and metacognitions can be achieved (Wells, 2009).

There are several limitations that must be acknowledged. Participants were gathered at convenience, consisted mainly of females and with moderate-low scores on rumination. The PANAS negative affect scale was used as the only indicator of the affective state, and while a general indicator of affectivity may contribute to demonstrating the general relevance (i.e., transdiagnostic nature) of the metacognitive model, the relationships might not hold for more specific indicators of depression or anxiety. Regarding scale indicators, a strength with the present study is that we used sound indicators of metacognitive factors, but latent factors may hide more specific relationships of relevance for clinical practice. For example, some metacognitive strategies might be of more important than others. Hoffart et al. (2023a) found that worry and threat monitoring were more strongly related to distress compared to avoidance. The time lag between data points is as noted a challenge in testing any psychotherapy model, and while our daily assessments add to the literature, there are likely complex relations between metacognitive factors and outcomes which warrant several studies with designs of a variety of time lags between assessment points. Furthermore, the different models did not allow us to perform a formal significance testing of the relative contribution from positive and negative metacognitive beliefs to negative affect mediated by metacognitive strategies in the same model, and we cannot therefore evaluate if the metacognitive belief domains are unique predictors of metacognitive strategies and negative affect when controlling their overlap. Nonetheless, testing bidirectional relationships between variables in the same model is a noted strength of the study since it is possible to use the standardized cross-lagged parameters to compare the relative strength of predictions (Schuurman et al., 2016). Allowing for random slopes increases model complexity, however, it allowed us to uncover findings related to the metacognitive model as we did not expect fixed effects for a sample gathered at convenience. There is ongoing debate as to whether variables should be grand, or group mean centred and at what level. With a focus on *within-person relationships* occurring at level 1 of the multilevel model, group mean centering was used in this study, standardizing the parameters per person first, and then taking the average. Adding a time grid of one day to weekend missing observations enables cases to approximate equally spaced time points – assumption of equidistance. However, such structural missingness, although common in longitudinal data, may not be missing at random. Future studies should evaluate different patterns of missingness when testing the metacognitive model with intensive longitudinal or daily diary data.

Future studies should continue to evaluate the metacognitive model from a within-person approach in clinical samples and over the course of therapy, which would allow an even more exhaustive examination of within-person mechanisms. The relative importance of metacognitive belief domains remains to be evaluated. Additionally, the transdiagnostic nature of the metacognitive model should be tested in different symptom domains considering the high comorbidity among mental health problems. There is also room for investigating alternative mediational pathways, for example to test if metacognitive beliefs mediate the relations between emotional distress and metacognitive strategies. Finally, experimental manipulations of metacognitive factors

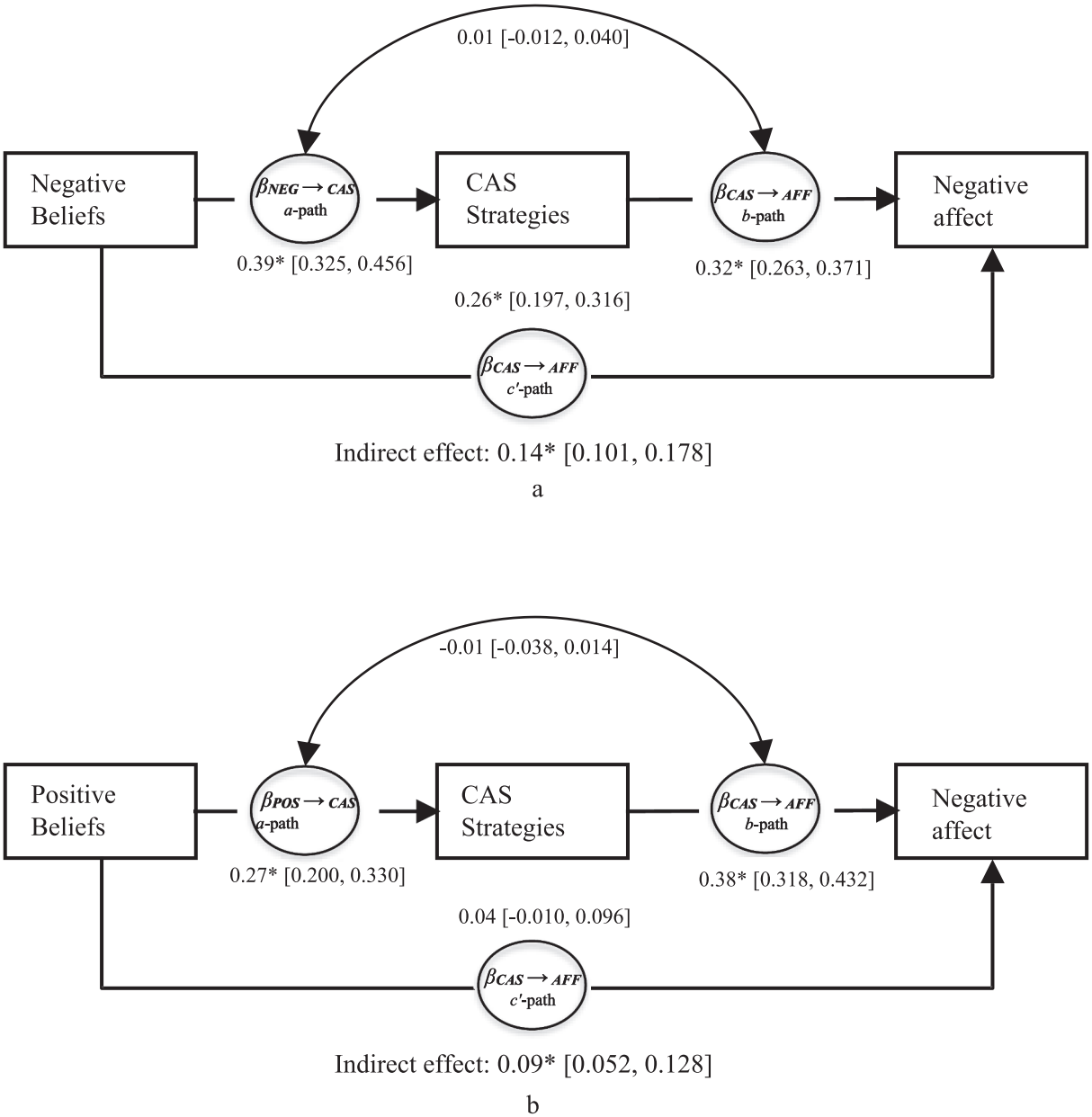



**Fig. 4.** a: Within-person mediation model for negative metacognitive beliefs (NEG), metacognitive strategies (CAS), and negative affect (AFF) within each day. b: Within-person mediation model for positive metacognitive beliefs (POS), metacognitive strategies (CAS), and negative affect (AFF) within each day.

and symptomatology are required to examinate the causal effects more accurately.

In conclusion, the present study adds to previous research by reporting within-person relationships between metacognitive beliefs, metacognitive strategies, and negative affect over and within days. Key findings are that there seem to be reciprocal relationships between metacognitive beliefs and negative affect over days, and that metacognitive strategies mediate the relationship between metacognitive beliefs and negative affect, particularly within days. Our results need to be tested in clinical samples but adds to the literature supporting some of the central tenets posited by the metacognitive model at the individual level.

## Declaration of Conflicting Interest

None.

## Funding

This study was part of projects funded by the Spanish Government, Spain (grant number PSI2017-83463-R). The funding source only provided financial support for this study and had no further involvement.

## CRediT authorship contribution statement

**JOSE MARTIN SALGUERO NOGUERA:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Henrik Nordahl:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Esperanza García-Sancho:** Validation, Supervision, Investigation, Conceptualization, Writing – review & editing. **Anyan Frederick:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Julia B. Cano-López:** Writing – review &

editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization.

## Declaration of Competing Interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

## Data availability

Data will be made available on request.

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