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Remembering or knowing how we felt: Depression and anxiety symptoms predict retrieval processes during emotional self-report

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Abstract

Researchers and clinicians routinely rely on patients' retrospective emotional self-reports to guide diagnosis and treatment, despite evidence of impaired autobiographical memory and retrieval of emotional information in depression and anxiety. To clarify the nature and specificity of these impairments, we conducted two large online data collections (Study 1: N=1983, Study 2: N=900) examining whether depression and/or anxiety symptoms would uniquely predict the use of self-reported episodic ("remembering") and/or semantic ("knowing") retrieval when rating one's positive and negative emotional experiences over different timeframes. Participants were randomly assigned to one of six timeframes (ranging from "at this moment" to "last few years") and were asked to rate how intensely they felt each of four emotions ("anxious," "sad," "calm," and "happy") over that period. Following each rating, they were asked several follow-up prompts assessing their perceived reliance on episodic and/or semantic information to rate how they felt, using procedures adapted from the traditional remember/know paradigm. Across both studies, depression and anxiety symptoms each uniquely predicted increased likelihood of "remembering" across emotion types, and decreased likelihood of "knowing" how one felt when rating positive emotion types. Implications for the theory and treatment of emotion-related memory disturbances in depression and anxiety, and for dual-process theories of memory retrieval more generally, are discussed.

As clinical researchers, diagnosticians, and mental health providers, we routinely ask individuals with depression and anxiety symptoms to reflect on how they have felt over various time intervals—from the "last two weeks" to months, years, or even their entire lifetime. Yet numerous studies have found that both depression and anxiety are linked to the preferential recall of negative (versus neutral or positive) autobiographical events and experiences (e.g., Burke & Mathews, 1992; Krans, de Bree, & Bryant, 2013; Wenzel & Cochran, 2006; see also Mitte, 2008, for a review). Some studies further show that individuals with (versus without) depression and anxiety pathology are more prone to *false* recall of negative (versus neutral or positive) information that was not previously presented (Hertel & Brozovich, 2010; Joormann, Teachman, & Gotlib, 2009; Wittekind et al., 2014).

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On the other hand, there are ample other studies that fail to find a relationship between emotional (i.e., depression and anxiety) disorder symptoms and memory bias (e.g., Bradley, Mogg, & Williams, 1995; Rinck & Becker, 2005; see also MacLeod & Mathews, 2004, for a review), suggesting that more research is needed to understand the nuanced links between emotional disorder symptoms and emotional memory retrieval. Uncovering these links has critical implications, not only for the validity of patients' emotional self-reports during diagnostic assessment, but also for their own self-concept and ability to learn from their experiences during treatment.

Cognitive models (e.g., Beck & Clark, 1997; Clark, 1999) attribute mood-congruent memory biases to the heightened accessibility of depressed and anxious individuals' negative self-beliefs, such that belief-congruent information is selectively retrieved, whereas belief-incongruent information is more easily forgotten. According to dual-process models of psychopathology (e.g., Beevers, 2005), depressed and anxious individuals rely too heavily on these global, decontextualized schematic beliefs to guide their information processing, and too little on contextual details, which is part of the reason their negative self-schemas get maintained. Consistent with this framework, depressed (versus non-depressed) individuals' autobiographical memories tend to be overgeneral and lacking in detail, particularly when recounting positive events (see Williams et al., 2007, for a review). This same pattern has been observed in individuals with trauma-related disorders (e.g., Kangas, Henry, & Bryant, 2005; Kleim & Ehlers, 2008; see Ono, Devilly, & Shum, 2016, for a review), though not those with other anxiety disorder symptoms (who instead tend to show enhanced recall of threat-related autobiographical events, and no difference in recall of positive events; see Zlomuzica et al., 2014, for a review).

Some researchers have suggested that these differences between high and low emotional symptom groups may reflect an aberrant use of semantic (i.e., relying on general, decontextualized beliefs) versus episodic (i.e., relying on specific, contextualized memories of situations) memory retrieval (e.g., Zlomuzica et al., 2014), in line with the dual process framework. For instance, the overgeneral memory observed in depressed individuals may be due to an over-reliance on decontextualized semantic self-beliefs and an under-reliance on specific episodic details to guide emotional memory retrieval. Similarly, the negative retrieval biases observed in anxious individuals may be due to a selective reliance on episodic details when recalling negative, but not positive, emotional experiences. However, the extent to which individuals with higher (versus lower) depression and/or anxiety symptoms differentially rely on semantic and/or episodic retrieval processes when recalling emotional information (positive or negative) has never before been tested, to our knowledge. This is a ripe area for research, because it may hold the key to future interventions that modify anxious and depressed individuals' distressing self-beliefs and associated symptoms by altering the way they retrieve emotional information. Indeed, the process of updating and modifying one's negative self-beliefs in light of disconfirming experiences is assumed to be a core mechanism of most cognitive-behavioral therapies (e.g., Hofmann, 2008). This process of incorporating positive as well as negative emotional experiences into one's self-concept may also be crucial for altering future disorder-congruent behavior, given the tendency for negative self-beliefs (such as "I am a sad person") to become self-fulfilling prophecies (e.g., Shafran, Thordarson, & Rachman, 1996). Thus, understanding the extent to

which individuals with anxiety and depression symptoms actually experience themselves incorporating their past experiences when recalling positive or negative emotional information is critical to evaluating and potentially improving treatments.

To test which retrieval processes individuals use when recalling self-relevant emotional information, we drew on a dual-process model of memory retrieval from cognitive psychology, which distinguishes between specific, contextually sensitive, episodic information retrieval (experienced as "remembering") and general, decontextualized semantic information retrieval (experienced as "knowing"). To examine the use of these retrieval processes when recalling self-relevant emotional information, we modified an existing paradigm within cognitive/social psychology (Robinson & Clore, 2002) in which participants rate the extent to which they have experienced various emotions (such as "happy," "sad," etc.) over different time intervals (ranging from "at this moment" to "the last few years"). This paradigm was designed to test Robinson and Clore's (2002) "accessibility model" of emotional self-report, which posits that individuals' reliance on episodic versus semantic retrieval depends on which type of information is more readily accessible in memory. Specifically, it was expected that concrete episodic details would be easier to access when recalling emotions over shorter timeframes (e.g., "last few hours," "last few days"), whereas one's general beliefs about oneself would become more readily accessible and thus "win out" over episodic recall when aggregating over longer, more remote intervals (e.g., "last few months," "last few years"). In the original paradigm, participants' response latencies when rating their emotional experience over these different timeframes were used as an indirect index of episodic versus semantic retrieval. In line with the "accessibility model," Robinson and Clore found that response latencies increased linearly over the first few timeframes (as participants presumably needed to survey increasingly more episodes and situational details in memory), but then "flattened out" over longer timeframes (as participants presumably switched into semantic, belief-based recall of how they generally feel).

To allow for a more direct test of which retrieval processes individuals experience themselves using when recalling emotions over these different timeframes, the current version of the paradigm prompted participants to report which retrieval process(es) they relied on, using prompts adapted from the classic "remember/know" paradigm in cognitive psychology (Tulving, 1985). This paradigm has traditionally been used to distinguish between episodic recall, indexed by the recollection of specific contextual details about the encoding phase (i.e., "remembering"), and semantic recall, indexed by a sense of general familiarity in the absence of specific recollected details (i.e., "knowing"). In the current study, we adapted the prompts from the classic "remember/know" paradigm by asking participants to report whether they "just knew" how they felt (semantic) and/or whether they "became conscious of specific episodes…" (episodic) when making each of their emotion ratings.

While traditional dual-process models assume that the two processes (semantic versus episodic memory retrieval) are mutually exclusive (e.g., Gardiner & Parkin, 1990), this assumption has been challenged by a growing body of theoretical and empirical research suggesting that these retrieval modes are not "process pure," but rather can occur

simultaneously and iteratively (e.g., Sadeh, Shohamy, Levy, Reggev, & Maril, 2011; Wixted, 2007). Thus we adapted the original forced-choice "remember/know" paradigm to allow for separate, independent ratings of whether participants relied on each retrieval mode, such that participants could endorse both remembering *and* knowing that they felt a given emotion.

Overview and Hypotheses

We conducted two large online data collections, including an original study and a replication and extension trial, to examine how depression and anxiety symptoms would predict the tendency to use semantic (i.e., ; "just know") and/or episodic (i.e., ; "remember") retrieval when recalling negative and positive emotions over different timeframes. We had two competing hypotheses about the overall relationship between emotional disorder symptoms and the use of each retrieval process, given the mixed findings in the memory bias literature to date. On the one hand, one might expect that greater depression and anxiety symptoms would be associated with overall greater use of semantic retrieval and lesser use of episodic retrieval when recalling emotional information, in line with cognitive models that propose greater reliance on schematic beliefs (e.g., Beevers, 2005). By this reasoning, it might also be expected that participants with greater depression and anxiety symptoms would "switch" into semantic retrieval mode at earlier time frames (e.g., at ratings tied to the past week versus the past month) than less symptomatic participants. On the other hand, it may be that the more symptomatic individuals have a larger store of salient and readily accessible emotion-related episodes to draw upon, and thus would be more likely to rely on episodic retrieval. Likewise, by this alternative reasoning, depressed and anxious individuals may be able to recall specific emotional episodes even over longer timeframes, and thus may be slower to "switch" into semantic retrieval mode than less symptomatic individuals. We also examined whether the relationship between depression or anxiety symptoms and type of recollection process would vary by emotion valence (i.e., positive vs. negative), given that depressed and anxious participants may have many more accessible episodes as well as stronger beliefs about their experience of negative compared to positive emotions. On the other hand, it may be that participants approach their ratings of positive and negative emotions in the same manner, simply regarding one as the negation of the other (e.g., interpreting "sad" as "not happy" or vice versa).

Finally, we tested whether the relationship between emotional symptoms and retrieval process(es) remained when controlling for the reported intensity of participants' emotions or for how confident they felt in their ratings. These secondary control variables were included in light of signal detection theories positing that the distinction between "remember" and "know" judgments simply reflects participants' level of confidence in their responses, rather than two distinct memory retrieval modes (e.g., Wixted, 2007; Wixted & Mickes, 2010). We did not have specific *a priori* hypotheses regarding these variables, in part given the novelty of the paradigm.

In sum, this is the first study to our knowledge to examine the relationship between anxiety and depression symptoms and memory retrieval processes used when recalling one's emotional experience over time. This research has critical implications for understanding the

negatively biased memories and self-beliefs that often plague emotionally disordered individuals, and for updating our therapeutic interventions accordingly.

Methods

Study 1

Participants—This study was approved by the University of Virginia's Institutional Review Board. It was administered on the Project Implicit website (www.implicit.harvard.edu) from April 4 through May 7, 2013. Of the 2865 individuals who viewed the consent form for the current study, 2526 consented to participate, and 1983 of these participants were randomly assigned to one of the six "timeframe" conditions being examined in this report.[1] This final sample was 66.2% female and ranged in age from 20 to 85 (mean = 34.7 years, *SD* = 14.1). Of these participants, 95.8% reported being US citizens. Race was reported as 65.1% White, 11.1% Black or African American, 8.9% Biracial, 6.2% Asian, and 8.7% other/not reporting. Ethnicity was reported as 74.9% not Hispanic or Latino, 10.2% Hispanic or Latino, and 14.9% other/not reporting. This was a relatively well-educated sample with 23.2% reporting having a graduate or other advanced degree, 23.1% having a Bachelor's degree or some graduate school, 47.2% having some college or an Associate's degree, and 5.5% having less than a college education. Although more diverse than a typical collegiate sample, Project Implicit samples are not representative of any one population (Nosek & Smyth, 2011). Of the final sample of 1983, 331 participants were randomly assigned to the "At this moment" condition, 345 to the "Last few hours" condition, 324 to the "Last few days" condition, 339 to the "Last few weeks" condition, 331 to the "Last few months" condition, and 313 to the "Last few years" condition.

Measures[2]

Emotion ratings task: To assess participants' retrieval processes while self-reporting emotions over different time intervals, we adapted Robinson and Clore's (2002) emotion rating paradigm. In the current study, participants were randomly assigned to one of seven time intervals (at this moment, last few hours, last few days, last few weeks, last few months, or last few years). At the start of the task, participants were instructed that they would be asked to judge the extent to which they have felt certain emotions over the specified time interval. They rated each emotion on a 5-point scale (ranging from 0=none to 4=an extreme amount), and were asked to respond as quickly and accurately as possible. Participants first completed five practice emotion rating items (including "angry," "surprised," "bored," "confident," and "irritated"), which were included to familiarize participants with the rating scale and response format. The follow-up "confidence" and "remember"/ "know" rating items (described below) were not administered following these five practice items, and data from these items were not used for analyses. After completing the practice ratings,

[1]We originally also included a seventh condition—"in general"—in keeping with Robinson and Clore's (2002) original paradigm, but excluded this condition from the current analyses given it does not represent a discrete time interval and thus does not fit conceptually with the other six timeframe conditions. A full set of results including this seventh condition is available from the first author.
[2]Additional measures were collected for a larger study, including an Implicit Association Test. More information about these measures is available from the first author.

participants were presented with the four target emotion rating items (“happy,” “sad,” “anxious,” and “calm”) in randomized order.

Confidence in emotion ratings: Following each of the four target emotion ratings, participants rated the extent to which they felt confident in the rating (on a scale from 1=not at all confident to 5=extremely confident).

Remembering versus knowing the experience of emotions: For each of the four target emotion ratings, two questions were administered to assess whether participants “remembered” versus “just knew” how much they had felt the given emotion over their assigned time interval. To assess *remembering*, participants were asked the following yes/no question: “When making your rating, did you become consciously aware of any specific aspect(s) of what happened or what was experienced when you felt [the given emotion] during that time period (e.g., specific details of particular events, situations, or physical sensations that occurred at the time) that helped you make your decision?” To assess *knowing*, participants were asked the yes/no question: “When making your rating, did you just know how much you felt [the given emotion] during that time period (e.g., based on your knowledge of how you generally feel) even though you did not become consciously aware of any specific aspect(s) of what happened or what was experienced?” This wording was designed to capture a basic assumption of Robinson and Clore’s (2002) accessibility theory, which posits that the recall of semantic information (experienced as “knowing”) should become the dominant recollection strategy only when the use of episodic information (experienced as “remembering”) is not readily accessible.

The *remembering* and *knowing* items were presented in random order.

Depression Anxiety and Stress Scale – 21-item version – Depression and Anxiety subscales: (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 measures self-reported symptoms of depression, anxiety, and stress over the past seven days. The present study used the 7-item depression and 7-item anxiety subscales. Scores can range from 0 to 42 within each domain, with higher scores reflecting worse symptoms. In the current sample, both scales exhibited high internal consistency, Cronbach’s α = .98 for DASS-A and .99 for DASS-D.

Procedure—Participants first viewed a consent page informing them that the purpose of the study was to examine “how intensely you feel different emotions and how you make decisions about those emotions.” Following informed consent, participants completed the Emotions Ratings task for their assigned timeframe (at this moment, last few hours, last few days, last few weeks, last few months, or last few years). The DASS-21 (depression and anxiety scales) were administered following the Emotions Ratings task. Debriefing information was provided at the end of the study.

Results

Table 1 presents an overall summary of the primary Study 1 results, as well as their replication status in Study 2.

Data preparation and descriptive statistics—DASS-A and -D scores (computed by taking the sum of all individual item ratings) were log-transformed to reduce positive skew. Figure 1 displays the overall proportions of participants who reported only "knowing," only "remembering," or both "knowing" and "remembering" the extent to which they felt each of the four emotions over each timeframe. Approximately 10% of participants responded "No" to both the "remember" and "know" follow-up items for a given emotion rating (9.1% for Anxiety ratings, 11.2% for Sadness ratings, 8.7% for Happiness ratings, and 12.4% for Calm ratings), and thus are not included in the Figure 1 plot.

Plan for analyses[3]—To examine whether participants' depression and/or anxiety symptoms predicted their reported recollection strategy(s) when rating emotions, and whether these effects differed across emotions and timeframes, we fitted separate generalized mixed-effects logistic regression models for each recollection type ("remember" and "know"), coded as a dichotomous "yes/no" outcome variable, regressed on each symptom measure (DASS-D or DASS-A, respectively, coded as a standardized continuous variable). The mixed effects modeling approach has well-documented advantages over more traditional analysis of variance (ANOVA) approaches, including improved accuracy and precision in modeling dichotomous outcomes (e.g., Jaeger, 2008). The other fixed effect predictors included in each model were "emotion type" (a within-subject factor with four levels: anxious, sad, happy, calm), "timeframe" (an ordered factor with six levels: at this moment, last few hours, last few days, last few weeks, last few months, and last few years), and all 2- and 3-way interaction terms. To test whether the effects of anxiety and depression symptoms were emotion-specific or generalized across emotions, we contrast-coded the "emotion type" factor such that "anxiety" was the reference level for analyses involving prediction by DASS-A, and "sadness" was the reference level for analyzes involving prediction by DASS-D.

To adjust for the familywise error rate arising from these multiple comparisons between the four emotion types, we applied a highly conservative Bonferroni correction (multiplying each p value by 3; i.e., the number of comparisons) for all predictor terms involving the Emotion Type factor. To estimate both the linear and curvilinear effects of timeframe on the likelihood of reporting a given recollection strategy (in line with the predictions of Robinson & Clore's [2002] "accessibility model"), we created orthogonal polynomial contrast codes that allow for the linear and quadratic trends of "timeframe" to be estimated as separate predictor terms.[4] Finally, to examine whether effects were unique to each symptom domain (depression and anxiety, respectively), the other symptom measure (DASS-A or D, respectively) was included as a covariate in each model. Additionally, a random effect of

[3]Given that our primary theoretical aim is to clarify what retrieval processes people experience themselves using when they make retrospective emotion ratings, we made the self-reported "remember"/ "know" items the focal point of our modified paradigm, and we present these items as our primary outcome measures in this manuscript. We did also record participants' reaction times as they rated each target emotion, but these reaction times were widely variable given that participants were asked to answer several follow-up prompts after each rating and made only four total target ratings. This task format differs enough from Robinson and Clore's (2002) original paradigm as to preclude any meaningful comparisons of the reaction time data. Nonetheless, we have made the results of our reaction time analyses available in the Online Supplement. The most robust reaction time findings (which replicated across the two samples) were: 1) ratings when "knowing" was endorsed (whether only "knowing" was endorsed, or "knowing" and "remembering" were both endorsed) tended to be faster than ratings when only "remembering" was endorsed; and 2) greater anxiety symptoms predicted overall *faster* emotion ratings (especially when rating Anxiety), whereas depression symptoms were generally not predictive of reaction time.

"subject" was included in each model to account for random within-subject variability in individual participants' recollection types. All models were fitted using the "lme4" package in R (R Core Team, 2013; Bates, Maechler, Bolker, & Walker, 2014).

To test whether the intensity or confidence level of participants' emotion ratings could account for the effects of emotional symptoms on recollection type, we re-ran each model with emotion ratings and confidence (both mean-centered) included as covariates. The full results of these analyses with emotion intensity and confidence as covariates are not reported in the manuscript, but are available in the Online Supplement. Across both samples, results indicated that controlling for the intensity of participants' self-reported emotion ratings tended to weaken (but not entirely eliminate) the effects of depression and anxiety symptoms on the likelihood of both remembering and knowing (with all but one effect remaining at least marginally significant). Controlling for participants' confidence ratings did not substantially influence the effects of emotional symptoms on recollection type (with all effects remaining significant). The full results of these analyses are available in the Online Supplement.

Given that both of our outcome variables were binary, we report effect sizes in the form of odds ratios (OR), which indicate how many times more or less likely a positive outcome (i.e., either "remembering" or "knowing") becomes with every one-standard-deviation increase in the predictor term.

Given the focus of the paper, only main effects and interactions involving DASS-A or DASS-D are reported below. Full regression statistics are available in the Online Supplement.

Anxiety symptoms as predictors of each recollection type

Remembering: As shown in Table 2a, there was a positive main effect of anxiety symptoms (DASS-A) on the likelihood that participants reported "remembering" (OR=1.43, p<.001), such that the odds of reporting "remembering" increased by approximately 43% for every one-standard-deviation increase in DASS-A score. No interaction terms involving DASS-A were significant.

Knowing: As shown in Table 2b, there was no significant main effect of anxiety symptoms (DASS-A) on the likelihood that participants reported "knowing" how they felt (OR=.99, p=.921); however, there was a 2-way DASS-A × Emotion Type (Calm vs Anxious) interaction (OR=.74, Bonferroni-corrected p=.006). Follow-up regression analyses split by Emotion Type (still controlling for DASS-D) indicated that the odds of reporting "knowing" were lower among those with higher DASS-A scores when rating Calm (OR=.83, p=.009), but not when rating Anxiety (OR=.95, p=.479). No other interaction terms involving DASS-A were significant.

[4]This contrast coding method generates predictor terms up to the k-1 polynomial level (where k=the number of levels of the factor); thus, given that the "timeframe" variable in the present analysis had six levels, the regression output yielded 5 estimates of increasing polynomial degree: linear, quadratic, cubic, quartic, and quintic. Only the linear and quadratic trends are reported here, given the theoretical focus of the manuscript; however the full model regression statistics are available from the first author.

Depression symptoms as predictors of each recollection type

Remembering: As shown in Table 3a, there was a significant main effect of depression symptoms (DASS-D) on the likelihood that participants reported "remembering" (*OR*=1.21, *p*=.017), indicating that the odds of reporting "remembering" how they felt increased by approximately 20% for every one-standard-deviation increase in DASS-D score. Additionally, there were significant DASS-D × Emotion Type (Calm vs Sad and Happy vs Sad) interactions (*OR*=.72 and .65, respectively; both Bonferroni-correct *p*≤.001). Follow-up regression analyses split by Emotion Type (still controlling for DASS-A) indicated that the positive effect of DASS-D on the odds of reporting "remembering" was only observed for Sadness ratings (*OR*=1.26, *p*=.001), whereas there was a *negative* effect of DASS-D when making either Calm (*OR*= .87, *p*=.044) or Happiness (*OR*=.80, *p*=.002) ratings. No other interactions involving DASS-D were significant.

Knowing: As shown in Table 3b, there was no main effect of DASS-D on the likelihood that participants reported "knowing" (*OR*=1.06, *p*=.500); however there were significant and marginally significant DASS-D × Emotion Type (Calm vs Sad and Happy vs Sad) interactions (*OR*=.73 and .81, respectively; Bonferroni-corrected *p*=.003 and .082, respectively), such that higher DASS-D predicted *lower* odds of "knowing" for Happiness ratings (*OR*= .86, *p*=.040) and a similar direction of effect for Calm ratings (though this effect did not reach significance; *OR*=.89, *p*=.115), whereas DASS-D was not predictive with respect to Sadness ratings (*OR*=1.01, *p*=.913). No other interactions involving DASS-D were significant.

Study 1 Summary and Study 2 Rationale—This study constituted our first test of a novel paradigm for assessing participants' self-reported retrieval processes when rating their emotional experience over time. In examining the overall rates with which participants reported using either or both retrieval processes to recall how they felt over different timeframes, we found that a majority of participants reported relying on *both* episodic (i.e., "remembering") and semantic (i.e., "knowing") information, contrary to Robinson and Clore's (2002) dual-process approach that assume these processes to be mutually exclusive (e.g., Gardiner & Parkin, 1990). The one exception to this pattern was with respect to Calm ratings, for which participants were equally likely to rely exclusively on "knowing" as on both "knowing" and "remembering" (Figure 1). Thus we modified the wording of the "know" follow-up prompt in the replication study so that it no longer implied mutual exclusivity between the two retrieval processes, and we further included a continuous relative rating item to assess the extent to which participants relied on either or both processes (see Study 2 Measures for details).

With respect to our primary research questions concerning the link between emotional symptoms and the use of episodic and/or semantic retrieval when recalling one's emotional experience, two notable patterns emerged. First, higher levels of anxiety and depression symptoms both uniquely predicted *greater* odds of reporting episodic retrieval (i.e., "remembering") across timeframes and (most) emotion types. By contrast, higher anxiety and depression symptoms both uniquely predicted *lower* odds of semantic retrieval (i.e., "knowing") when rating happiness and/or calm, again regardless of timeframe. Given we

had not originally hypothesized this pattern of findings, we sought to replicate it in Study 2, which followed the same recruitment procedures and experimental design, with the minor refinements noted above (and detailed under Study 2 Measures below).

Study 2: Replication and Refinement

Method

Participants—This replication study was again approved by the University of Virginia's Institutional Review Board, and was administered on the Project Implicit website from June 12 to September 1, 2014. Of the 1944 individuals who viewed the consent form for the study, 1035 consented to participate, of whom 900 continued and were randomly assigned to one of the six "timeframe" conditions. This final sample was 65.6% female and ranged in age from 18 to 90 (mean = 36.1 years, *SD* = 15.0). All participants reported being U.S. citizens. Race was reported as 69.2% White, 14.2% Black or African American, 6.3% Biracial, 3.7% Asian, and 6.6% other/not reporting. Ethnicity was reported as 78.6% not Hispanic or Latino, 9.1% Hispanic or Latino, and 12.3% other/not reporting. This was again a relatively well-educated sample, with 27.3% reporting having a graduate or other advanced degree, 27.6% having a Bachelor's degree or some graduate school, 39.0% having some college or an Associate's degree, and 7.8% having less than a college education. Of the final sample of 900, 123 participants were randomly assigned to the "At this moment" condition, 139 to the "Last few hours" condition, 167 to the "Last few days" condition, 152 to the "Last few weeks" condition, 170 to the "Last few months" condition, and 149 to the "Last few years" condition.

Measures—The replication study included all the same measures listed above for Study 1. Several minor modifications were made to the emotion ratings task: first, the wording of the *remember* item was slightly streamlined for improved readability; it now asked: "When making your rating, did you become consciously aware of any specific details of how you felt during that time period (e.g., particular events, situations, or physical sensations that occurred at the time) that helped you make your decision?" Second, given that a high proportion of the Study 1 sample endorsed both "remembering" and "knowing" how they felt for a given emotion, we re-worded the *knowing* item so that it did not imply that these two retrieval processes are mutually exclusive. This item then read: "When making your rating, did you **just know** how much you felt anxious during that time period (e.g., based on your knowledge of how you generally feel), regardless of whether or not you were aware of any specific details of how you felt?" The ordering and response format of these follow-up items was otherwise identical to that of Study 1.

Continuous "remember/know" rating: Additionally, to allow for a more relative assessment of the extent to which participants relied on either or both recall processes, we included a further follow-up item after each emotion rating that read: "Using the scale below, please indicate to what extent you based your rating of how much you felt the given emotion on remembering specific details of how you felt during that time period ("Remembering") versus your general sense of just knowing how you felt during that time period ("Knowing")." This item was rated on a 7-point scale that ranged from 1="Only

remembering" to 7="Only Knowing," with 4="Equally remembering and knowing." In line with the findings of Study 1, we hypothesized that participants with higher depression or anxiety symptoms would endorse more "remembering" than "knowing," particularly for positive emotions.

Procedure—The replication study repeated the procedure in Study 1. The continuous "remember/know" rating item was always presented after the dichotomous "remember" and "know" items following each emotion rating, which were again presented in random order.

Results

Data Preparation and Descriptive Statistics

As in Study 1, DASS-A and DASS-D were log-transformed to reduce positive skew. The relative proportions of participants who reported only "knowing," only "remembering," or both "knowing" and "remembering" the extent to which they felt each of the four emotions over each timeframe closely resembled those found in Study 1 (see Figure 1). As in Study 1, a majority of participants (in the 52–56% range) reported both "remembering" and "knowing" how often they felt every emotion except "calm," for which there were roughly equal numbers of participants reporting that they both "remembered" and "knew" (40.1%) and that they "knew" but did not "remember" (41.8%). Likewise, as in Study 1, only a small minority of participants responded "No" to both recollection types for a given emotion rating (5.7% for Anxiety ratings, 7.1% for Sadness ratings, 7.6% for Happiness ratings, and 10.0% for Calm ratings).

Plan for Analyses

In addition to replicating the logistic regression analyses described in Study 1 (see Primary Analyses above), we also fitted standard linear mixed-effects regression models with the "remember/know" rating item entered as the continuous outcome measure (and regressed onto the same sets of fixed and random effect predictor terms as for the logistic regression models described in Primary Analyses above). A Bonferroni correction was again applied to any predictor terms involving Emotion Type. Again, given the focus of the paper, only main effects and interactions involving DASS-A or DASS-D are reported below, though full regression statistics are available in the Online Supplement.

Anxiety symptoms as predictors of recollection type

Remembering—As shown in Table 4a, there was again a positive main effect of anxiety symptoms (DASS-A) on the likelihood that participants reported "remembering" (OR=1.90, p<.001), such that the odds of reporting "remembering" increased by 90% (i.e., almost two-fold) for every one-standard-deviation increase in DASS-A score—thus replicating the main effect finding in Study 1. In addition, there were significant DASS-A × Emotion Type (Sad vs. Anxious and Happy vs. Anxious) interactions (OR=.71 and .68, respectively; Bonferroni-corrected p=.033 and .012, respectively), such that the effect of higher DASS-A on greater likelihood of remembering was stronger for Anxiety (OR=1.63, p<.001) than for either Sadness (OR=1.14, p=.159) or Happiness (OR=1.27, p=.006) ratings.

Knowing—As shown in Table 4b, there was no main effect of DASS-A on the likelihood of reporting "knowing" (*OR*=.92, *p*>.10). However there was a significant 2-way DASS-A × Linear Timeframe interaction (*OR*=1.90, *p*=.030) subsumed within a marginally significant 3-way DASS-A × Emotion Type (Calm vs Anxious) × Linear Timeframe interaction (*OR*=.41, Bonferroni-corrected *p*=.056). To clarify this 3-way interaction, we conducted follow-up regression analyses split by Emotion Type, Timeframe, and/or high versus low DASS-A median-split groups (still controlling for continuous DASS-D in all analyses). As shown in Figure 2, the pattern of results partially replicated the emotion-specific finding in Study 1, such that higher DASS-A became associated with a lower likelihood of reporting "knowing" how they felt when rating Calm versus Anxious, but only at later timeframes. In contrast to Study 1, there was also a 2-way DASS-A × Linear Timeframe interaction (*OR*=1.70, *p*=.025) when rating Anxiety, such that the likelihood of reporting "knowing" increased over longer timeframes among those with high DASS-A scores (*OR*=1.84, *p*=.036), whereas there was a marginally significant *decrease* in "knowing" over longer timeframes among those with low DASS-A scores (*OR*=.53, *p*=.091). There were no DASS-A × Linear Timeframe interactions when rating either Sadness or Calm (both *p*>.10).

Continuous "remember/know" rating—As shown in Table 4c, there was a small but significant negative main effect of DASS-A on the "remember/know" rating response (standardized *B*=−.13, *p*<.001), such that participants with higher DASS-A scores were closer to the "remembering" (rather than "knowing") end of the scale, as hypothesized. There was also a DASS-A × Linear Timeframe interaction (standardized *B*=.19, *p*=.043), such that the effect of DASS-A became less negative with longer timeframes.

Depression symptoms as predictors of each recollection type

Remembering—As shown in Table 5a, there was no main effect of depression symptoms (DASS-D) on the likelihood of "remembering" (*OR*=.98, *p*=.876), thus failing to replicate the main effect finding in Study 1. However there was a significant DASS-D × Emotion Type (Happy vs Sad) interaction (*OR*=.73, Bonferroni-corrected *p*=.0496), such that higher DASS-D scores predicted lower likelihood of "remembering" for "happiness" (*OR*=.76, *p*=.005) but not for "sadness" (*OR*=1.09, *p*=.345) ratings, thus partially replicating the emotion-specific findings in Study 1. No other interactions involving DASS-D were significant.

Knowing—As shown in Table 5b, there was no significant main effect of DASS-D predicting the likelihood of "knowing" (*OR*=1.07, *p*=.619). However there were significant 2-way DASS-D × Emotion Type (Calm vs Sad and Happy vs Sad) interactions (*OR*=.69 and .68, respectively; Bonferroni-corrected *p*=.044 and .032, respectively), such that there was a relatively greater negative effect of DASS-D on the likelihood of "knowing" when rating Happiness (*OR*=.79, *p*=.029) and Calm (though this effect did not reach significance; *OR*=.85, *p*=.134) than when rating Sadness (*OR*=.93, *p*>.10), thus replicating the emotion-specific finding in Study 1. Additionally, there was a 3-way DASS-D × Emotion Type (Anxious vs Sad) × Linear Timeframe interaction (*OR*=3.37, Bonferroni-corrected *p*=.006) predicting the likelihood of "knowing." To clarify this 3-way interaction, we conducted follow-up regression analyses split by Emotion Type, Timeframe, and/or high versus low DASS-D median-split groups (still controlling for continuous DASS-A in all analyses).

These follow-up analyses revealed that for those with high (but not low) DASS-D, the likelihood of "knowing" that one felt Sadness marginally decreased over longer timeframes (*OR*=.58, *p*=.077), whereas the likelihood of "knowing" that one felt Anxiety significantly increased over longer timeframes (*OR*=1.83, *p*=.034).

Continuous "remember/know" rating—As shown in Table 5c, there was a small but significant positive main effect of DASS-D on the "remember/know" rating (standardized *B*=.12, *p*=.003); contrary to our hypothesis, participants with higher DASS-D scores were closer to the "knowing" (rather than "remembering") end of the scale. No interactions involving DASS-D were significant.

Study 2 Summary

Results from Study 2 partially replicated those of Study 1: Specifically, individuals with higher anxiety symptoms again showed overall greater odds of "remembering" how they felt, regardless of timeframe or emotion type, whereas individuals with higher depression symptoms showed overall *lower* odds of "knowing" the extent to which they felt positive (but not negative) emotions. The remaining findings showed a broadly similar pattern but were more nuanced with respect to the influence of timeframe and emotion type. Finally, results from the continuous "remember/know" rating item were consistent with hypotheses for DASS-A (with higher symptoms predicting overall greater reliance on "remembering" than "knowing" how one felt) but not for DASS-D, which showed the opposite pattern.

Discussion

These two studies examined the unique role of anxiety and depression symptoms, respectively, in predicting the tendency to rely on episodic (i.e., "remembering") and/or semantic (i.e., "knowing") retrieval processes when recalling positive and negative emotional experiences over time. The most consistent findings across the two studies were that higher anxiety symptoms predicted overall greater likelihood of "remembering" the extent to which one felt any given emotion, while higher depression symptoms predicted lower likelihood of "knowing" the extent to which one felt positive (but not negative) emotions. With one isolated exception, these effects tended to apply equally across all time intervals, from "at this moment" to "last few years," suggesting that the need to survey increasingly more experiences over longer timeframes is not what drives these emotional symptom effects. More generally, the two data collections revealed that most participants report both "remembering" and "knowing" how they felt, contrary to traditional dual process models that assume these two retrieval processes to be mutually exclusive (e.g., Gardiner & Parkin, 1990; Robinson & Clore, 2002). This departure from Robinson and Clore's (2002) original findings in support of a dual-process accessibility model of emotional self-report may be partly due to the ways we modified their paradigm: for instance, we used a between-subject rather than within-subject design to avoid asking the same participants to rate the same emotion over multiple time intervals, given the potential for the same episodes to be accessed in memory across overlapping timeframes (e.g., situations occurring over the "last few days" may also be relevant over the "last few weeks," and vice versa). We also gave participants the option (more explicitly in Study 2 than in Study 1) to endorse both

"remembering" and "knowing" how they felt, which allowed for a more direct test of their incompatibility than would have been possible with the original reaction time paradigm.

The finding that emotional symptoms (and particularly anxiety symptoms) predict overall greater rather than lesser use of episodic retrieval, or "remembering," is somewhat at odds with cognitive models suggesting that anxious and depressed individuals are quicker to rely on their schematic self-beliefs than to recall the episodic details of their emotional experiences (e.g., Beevers, 2005). On the contrary, the current finding suggests that these individuals may have a larger reserve of salient and readily-accessible emotional episodes available in memory, and/or they may have a stronger and more well-rehearsed tendency to retrieve and mentally process the emotional aspects of past situations. The latter possibility would be in line with some accounts of maladaptive, self-focused rumination (e.g., Kross, Ayduk, & Mischel, 2005), particularly in the context of social anxiety disorder (Wong & Moulds, 2012).

Of note, however, the tendency to access the specific *emotional* aspects of past situations (e.g., "how anxious I felt during that date") may be distinct from the tendency to retrieve other, less emotion-focused contextual details of these situations (e.g., "the conversational topics we covered," "the desserts we both ordered," etc.). Thus, it may be that emotionally disordered individuals preferentially recall the details of their emotional states but not the other contextual aspects of the situations they encounter, which may lead to an incomplete and negatively skewed impression of such situations, thereby only further reinforcing their negative self-beliefs. Indeed, given past findings for the reduced specificity of autobiographical memories in depressed individuals and those with trauma-related disorders (see Ono et al., 2016), it may be that the enhanced recall of emotional details does not extend to, and perhaps even interferes with, the recall of other contextual details. For instance, an anxious or depressed individual may vividly recall the intense discomfort she felt while going up to present in front of her colleagues, but may not recall the favorable feedback she received afterward or the constructive organizational changes that resulted from her presentation. Notably, this differential recall is likely only partially accounted for by the more intense negative affect experienced by anxious and depressed individuals, given that many of the symptom effects on reported retrieval processes remained at least marginally significant after controlling for emotion rating intensity (see Online Supplement). Future research is needed to differentiate between the retrieval processes used when recalling emotions versus other aspects of one's experience (e.g., loud versus quiet environments, warm versus chilly weather, etc.), and the extent to which emotional symptoms predict "remembering" versus "knowing" in each case.

The most notable and unexpected finding that replicated across the two studies was that emotional symptoms (particularly depression symptoms) predicted *lower* use of semantic information retrieval (i.e., "knowing") when recalling positive emotions (namely "happy" and/or "calm"). These results challenge the traditional view that emotional disorders are characterized by over-reliance on global, schema-driven semantic processing. On the contrary, our findings suggest that individuals with emotional disorder symptoms may have less robust or accessible self-beliefs to draw upon when recalling positive emotions, despite being as or more likely to report recollecting specific situations in which they felt these

emotions. One possible explanation for these findings is that depressed and anxious individuals have difficulty integrating their positive emotional experiences into their overall self-knowledge. If so, this difficulty may need to be targeted more explicitly in psychosocial treatments for depression and anxiety, which currently tend to focus more on the reduction of negative biases and self-beliefs (an emphasis that has increasingly come under criticism by proponents of positive psychology and wellbeing-focused interventions; e.g., Seligman, Rashid, & Parks, 2006). Interestingly, these effects remained significant even when covarying participants' differential levels of confidence in their emotion ratings, suggesting that this reduced sense of self-knowledge about their positive emotional states cannot simply be attributed to lower trust or confidence in their recollection accuracy. Thus, in addition to intervention strategies aimed at increasing general self-confidence and memory specificity, it may be necessary to develop techniques that more directly address how patients interpret and weigh the significance of both positive and negative evidence when arriving at their self-beliefs.

Limitations and Conclusions

The current findings should be considered in light of several limitations. First, results from an unselected sample of individuals with varying levels of self-reported depression and anxiety symptoms may or may not be generalizable to diagnosed clinical samples, which will need to be determined in future research. Second, the use of a cross-sectional, single-session online emotion rating paradigm precluded the possibility of assessing how accurately participants rated their emotions over each retrospective timeframe. Future research utilizing a longitudinal, experience-sampling design will be better suited to test the discrepancy between participants' "real-time" emotion ratings and their retrospective self-reports, and whether the extent of this discrepancy differs based on retrieval process. Third, participants' self-reported retrieval processes may or may not accurately represent what they "actually did" to arrive at their emotion ratings, given the difficulty of correctly introspecting on such a complex and partially unconscious retrieval process (e.g., Buchanan, 2007). In the future it will be important to test the robustness of these results when using alternative means of prompting and assessing "remember" versus "know" processes, including behavioral and potentially neural measures. Of note, however, cognitive psychology research utilizing the "remember/know" paradigm has shown close correspondence between participants' self-reports of "remembering" versus "knowing" whether they had previously seen a given experimental stimulus, on the one hand, and their objective recall performance (e.g., Wixted & Mickes, 2010) and patterns of neural activation (e.g., Yu, Johnson, & Rugg, 2012), on the other hand. Interestingly, approximately 10% of participants across both studies denied either "remembering" or "knowing" how they felt, suggesting that these two processes may not be as exhaustive as assumed by more traditional, forced-choice versions of the remember/know paradigm. Future research will be needed to ascertain what kind of recollection process these participants experience themselves going through in order to arrive at their emotion ratings, and whether or not they are interpreting the "remembering" and "knowing" prompts in the same way as do the other participants.

Regardless of how well participants' subjective self-reports map onto their actual retrieval process, the current findings raise the possibility that anxious and depressed individuals'

perceived retrieval process could be a fruitful intervention target in its own right. For instance, by training highly depressed individuals to count their recollection of specific positive emotional experiences as evidence toward what they "know" about themselves, we may be able to improve their subjective self-appraisals and give them a more balanced view of their own emotional selves. Of course, this proposal will need to be tested in future studies that experimentally manipulate participants' use of each retrieval process when reporting on their emotional experience.

These limitations and open questions notwithstanding, the current studies introduce a novel application of the remember/know methodology for investigating how individuals arrive at their retrospective emotional self-reports. Results from this paradigm, which were partly replicated across two large, independent online data collections, shed new light on the role of depression and anxiety symptoms in predicting what retrieval processes individuals experience themselves using when recalling their emotional experiences over time. These findings challenge the assumptions of several existing theoretical frameworks (such as traditional dual-process models and cognitive models of emotional disorders) and suggest some promising new directions for clinical intervention. More broadly, the current research offers a blueprint for integrating the tools and concepts of social, cognitive, and clinical psychology in order to gain a wider, more parsimonious view of the common psychological processes (such as emotional processing and autobiographical memory retrieval) that are informed by each of these disciplines.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Bates, D; Maechler, M; Bolker, B; Walker, S. lme4: Linear mixed-effects models using Eigen and S4. R package version 1.0-6. 2014. http://CRAN.R-project.org/package=lme4
2. Beck AT, Clark DA. 1997; An information processing model of anxiety: Automatic and strategic processes. Behaviour Research and Therapy. 35:49–58. [PubMed: 9009043]
3. Bradley BP, Mogg K, Williams R. 1995; Implicit and explicit memory for emotion-congruent information in clinical depression and anxiety. Behav Res Ther. 33(7):755–70. [PubMed: 7677713]
4. Beevers CG. 2005; Cognitive vulnerability to depression: A dual process model. Clinical Psychology Review. 25:975–1002. [PubMed: 15905008]
5. Buchanan TW. 2007; Retrieval of Emotional Memories. Psychological Bulletin. 133(5):761–779.h. [PubMed: 17723029]
6. Burke M, Mathews A. 1992; Autobiographical memory and clinical anxiety. Cognition and Emotion. 6:23–35.
7. Cisler JM, Koster EHW. 2010; Mechanisms of attentional biases towards threat in the anxiety disorders: an integrative review. Clin. Psychol. Rev. 30(2):203–216. [PubMed: 20005616]
8. Clark DM. 1999; Anxiety disorders: why they persist and how to treat them. Behav. Res. Ther. 37:5–27.

9. de Quervain DJ, Margraf J. 2008; Glucocorticoids for the treatment of post-traumatic stress disorder and phobias: a novel therapeutic approach. Eur. J. Pharmacol. 583:365–371. [PubMed: 18275950]
10. Golden AM, Dalgleish T, Mackintosh B. 2007; Levels of specificity of autobiographical memories and of biographical memories of the deceased in bereaved individuals with and without complicated grief. J Abnorm Psychol. 116(4):786–95. [PubMed: 18020724]
11. Gardiner JM, Parkin AJ. 1990; Attention and recollective experience in recognition memory. Memory & Cognition. 18:579–583. [PubMed: 2266859]
12. Gotlib IH, Joormann J. 2010; Cognition and depression: Current status and future directions. Annual Review of Clinical Psychology. 6:285–312.
13. Gotlib IH, Kasch KL, Traill S, Joormann J, Arnow BA, Johnson SL. 2004; Coherence and specificity of information processing biases in depression and social phobia. Journal of Abnormal Psychology. 113:386–398. DOI: 10.1037/0021-843X.113.3.386 [PubMed: 15311984]
14. Hertel PT, Brozovich F. 2010; Cognitive habits and memory distortions in anxiety and depression. Current Directions in Psychological Science. 19(3):155–160.
15. Hofmann SG. 2008; Cognitive processes during fear acquisition and extinction in animals and humans: Implications for exposure therapy of anxiety disorders. Clinical Psychology Review. 28(2):199–210. [PubMed: 17532105]
16. Jaeger TF. 2008; Categorical Data Analysis: Away from ANOVAs (transformation or not) and towards Logit Mixed Models. Journal of Memory and Language. 59(4):434–446. [PubMed: 19884961]
17. Joormann J, Teachman BA, Gotlib IH. 2009; Sadder and Less Accurate? False Memory for Negative Material in Depression. Journal of Abnormal Psychology. 118(2):412–417. [PubMed: 19413415]
18. Kangas M, Henry JL, Bryant RA. 2005; A prospective study of autobiographical memory and posttraumatic stress disorder following cancer. Journal of Consulting and Clinical Psychology. 73:293–299. [PubMed: 15796637]
19. Kleim B, Ehlers A. 2008; Reduced autobiographical memory specificity predicts depression and posttraumatic stress disorder after recent trauma. Journal of Consulting and Clinical Psychology. 76:231–242. [PubMed: 18377120]
20. Krans J, de Bree J, Bryant RA. 2013Autobiographical memory bias in social anxiety. Memory. :1–8. [PubMed: 23731185]
21. Kross E, Ayduk O, Mischel W. 2005; When asking"why" does not hurt: Distinguishing rumination from reflective processing of negative emotions. Psychological Science. 16(9):709–715. [PubMed: 16137257]
22. Lotterman JH, Bonanno GA. 2014; Those were the days: memory bias for the frequency of positive events, depression, and self-enhancement. Memory. 22(8):925–36. [PubMed: 24266841]
23. Lovibond, SH, Lovibond, PF. Manual for the depression anxiety stress scales. 2. Sydney: Psychology Foundation; 1995.
24. MacLeod, C, Mathews, A. Selective memory effects in anxiety disorders: An overview of research findings and their implications. In: Reisberg, D, Hertel, P, editors. Memory and emotion. New York: Oxford University Press; 2004. 155–185.
25. MacLeod C, McLaughlin K. 1995; Implicit and explicit memory bias in anxiety: a conceptual replication. Behav Res Ther. 33(1):1–14. [PubMed: 7872931]
26. Mitte K. 2008; Memory bias for threatening information in anxiety and anxiety disorders: a meta-analytic review. Psychol. Bull. 134:886–911. [PubMed: 18954160]
27. Morgan J. 2010; Autobiographical memory biases in social anxiety. Clin. Psychol. Rev. 30:288–297. [PubMed: 20067854]
28. Nosek BA, Smyth FL. 2011Implicit social cognitions predict sex differences in math engagement and achievement. American Educational Research Journal.
29. Ono M, Devilly GJ, Shum DH. 2016; A meta-analytic review of overgeneral memory: The role of trauma history, mood, and the presence of posttraumatic stress disorder. Psychol Trauma. 8(2): 157–64. [PubMed: 25961867]

30. Raes F, Hermans D, Williams JMG, Demyttenaere K, Sabbe B, Pieters G, Eelen P. 2006; Is overgeneral autobiographical memory an isolated memory phenomenon in major depression? Memory. 14:584–594. [PubMed: 16754243]
31. Rinck M, Becker ES. 2005; A comparison of attentional biases and memory biases in women with social phobia and major depression. J Abnorm Psychol. 114(1):62–74. [PubMed: 15709813]
32. Robinson M, Clore G. 2002; Belief & Feeling: Evidence for an Accessibility Model of Emotional Self-Report. Psychological Bulletin. 128(6):934–960. [PubMed: 12405138]
33. Sadeh T, Shohamy D, Levy DR, Reggev N, Maril A. 2011; Cooperation between the hippocampus and the striatum during episodic encoding. J Cogn Neurosci. 23:1597–1608. [PubMed: 20666593]
34. Seligman MEP, Rashid T, Parks AC. 2006; Positive psychotherapy. Ampsychol. 61:774–88.
35. Shafran R, Thordarson DS, Rachman S. 1996; Thought-action fusion in obsessive compulsive disorder. Journal of Anxiety Disorders. 10(5):379–391.
36. Tulving E. 1985; Memory and consciousness. Can Psychol. 26:1–12.
37. Wenzel A, Cochran CK. 2006; Autobiographical memories prompted by automatic thoughts in panic disorder and social phobia. Cogn. Behav. Ther. 35:129–137. [PubMed: 16952896]
38. Williams JMG, Barnhofer T, Crane C, Herman D, Raes F, Watkins E, et al. 2007; Autobiographical memory specificity and emotional disorder. Psychol. Bull. 133:122–148. [PubMed: 17201573]
39. Wittekind CE, Terfehr K, Otte C, Jelinek L, Hinkelmann K, Moritz S. 2014; Mood-congruent memory in depression – The influence of personal relevance and emotional context. Psychiatry Research. 215(3):606–613. [PubMed: 24445164]
40. Wixted JT. 2007; Spotlighting the Probative Findings: Reply to Parks and Yonelinas (2007). Psychological Review. 114(1):203–209.
41. Wixted JT, Mickes L. 2010; A continuous dual-process model of remember/know judgments. Psychological Review. 117(4):1025–1054. [PubMed: 20836613]
42. Wong QJJ, Moulds ML. 2012; Processing mode during repetitive thinking in socially anxious individuals: Evidence for a maladaptive experiential mode. Journal of Behavior Therapy and Experimental Psychiatry. 43(4):1064–1073. [PubMed: 22695223]
43. Yu SS, Johnson JD, Rugg MD. 2012; Hippocampal activity during recognition memory co-varies with the accuracy and confidence of source memory judgments. Hippocampus. 22:1429–1437. [PubMed: 22076964]
44. Zlomuzica A, Dere D, Machulska A, Adolph D, Dere E, Margraf J. 2014; Episodic Memories in Anxiety Disorders: Clinical Implications. Frontiers in Behavioral Neuroscience. 8:131. [PubMed: 24795583]

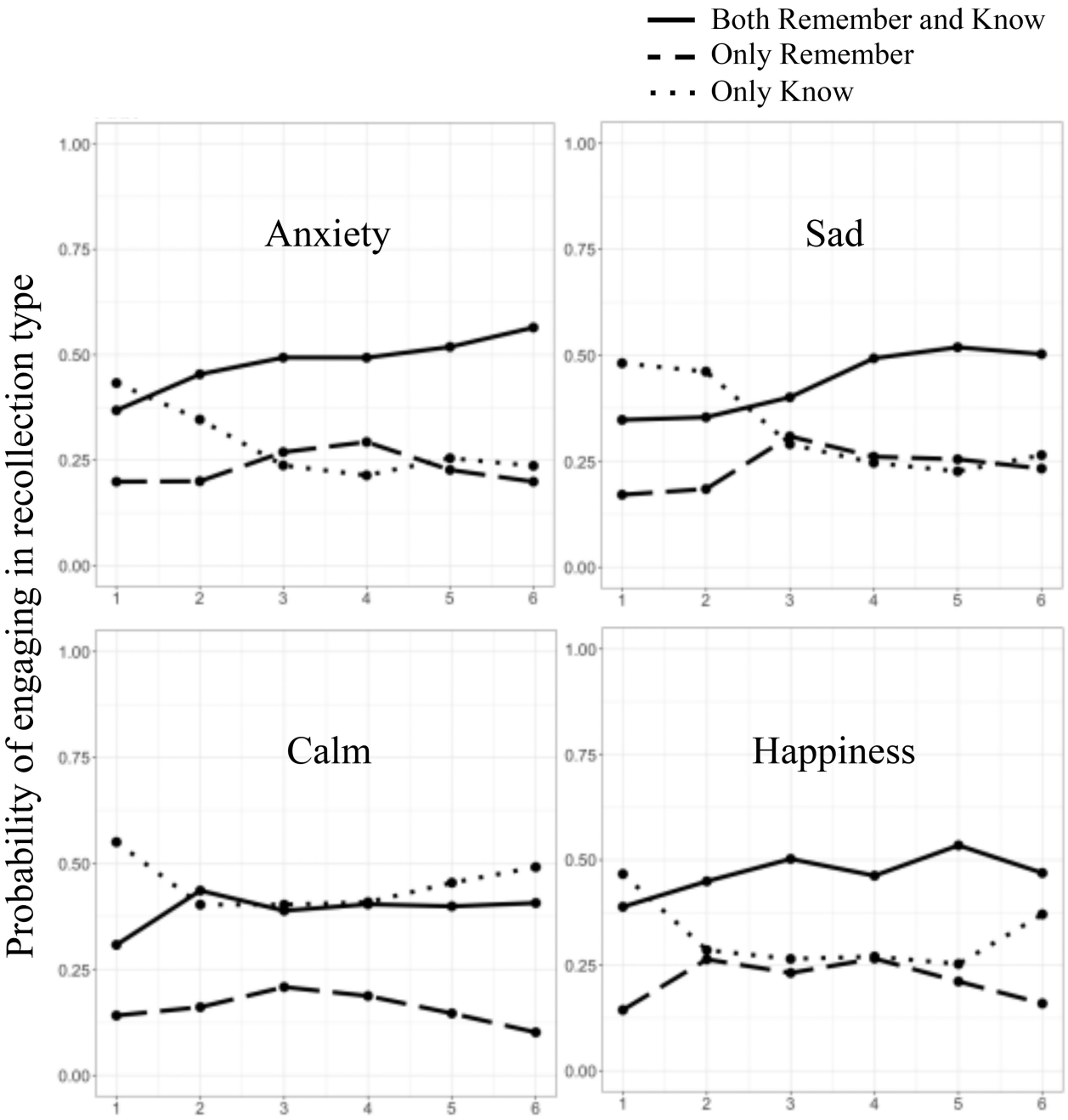

Figure 1.

Overall proportions of participants who reported "remembering", "knowing", or both "remembering" and "knowing" the extent to which they felt each emotion (anxiety, sadness, calm, and happiness) over the six timeframes (Study 1).

Notes. x-axis: 1="At this moment", 2="Last few hours", 3="Last few days", 4="Last few weeks", 5="Last few months", 6="Last few years."

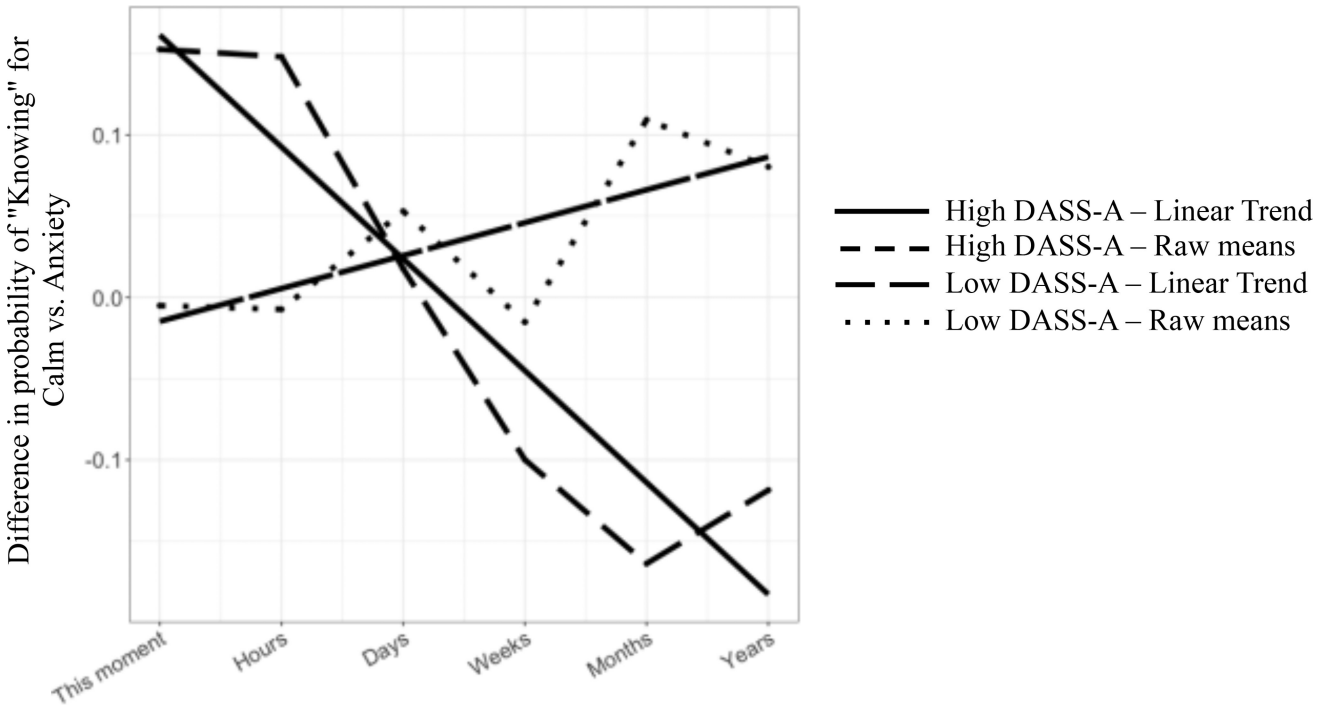

Figure 2.

Difference in probability of "knowing" for Calm versus Anxiety, split by timeframes and high versus low anxiety symptoms (DASS-A) (Study 2).

Table 1

Summary table of Study 1 findings and their Study 2 replication status.

Predictor	Outcome	Study 1 result	Replicated in Study 2?
Anxiety symptoms (DASS-A)	Remembering vs not remembering	Higher DASS-A --> Higher odds of remembering (main effect).	**Yes**
	Knowing vs not knowing	Higher DASS-A --> Lower odds of knowing (only for Calm).	Partial; Higher DASS-A à Lower odds of knowing (only for Calm at Last few months).
Depression symptoms (DASS-D)	Remembering vs not remembering	Higher DASS-D --> Higher odds of remembering (main effect); higher odds for Sadness vs lower odds for Happiness & Calm.	Partial; Higher DASS-D à Lower odds of remembering for Happiness but not Sadness.
	Knowing vs not knowing	Higher DASS-D --> Lower odds of knowing (only for Happy and, to lesser extent, Calm).	**Yes**

Notes. DASS-A = Depression, Anxiety, and Stress Scales - Anxiety Subscale. DASS-D = Depression, Anxiety, and Stress Scales – Depression Subscale.

Table 2

***a.*Anxiety symptoms (DASS-A) as a predictor of the likelihood of "remembering" versus "not remembering" across emotion types and timeframes, controlling for depression symptoms (DASS-D) (Study 1).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Random Effects							
Participants (N=1370)							
Intercept	1.22	1.11					
Fixed Effects							
Intercept			.78	2.19	.07	10.44	<.001
DASS-A			**.36**	**1.43**	**.08**	**4.43**	**<.001**
DASS-D (as covariate)			−.05	.95	.05	−.91	.363
Sad vs Anxious			−.25	.78	.09	−2.67	.008
Calm vs Anxious			−.92	.40	.09	−9.75	<.001
Happy vs Anxious			−.13	.88	.09	−1.37	.170
Timeframe (linear trend)			.77	2.15	.18	4.21	<.001
Timeframe (quadratic trend)			−.69	.50	.18	−3.75	<.001

***b.* Anxiety symptoms (DASS-A) as a predictor of the likelihood of "knowing" versus "not knowing" across emotion types and timeframes, controlling for depression symptoms (DASS-D) (Study 1).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Random							
Effects							
Participants (N=1378)							
Intercept	1.441	1.20					
Fixed Effects							
Intercept			1.07	2.92	.08	13.68	<.001
DASS-A			−.01	.99	.08	−.10	.921
Sad vs Anxious			−.11	.90	.10	−1.13	.260
Calm vs Anxious			.29	1.34	.10	2.98	.003
Happy vs Anxious			.14	1.15	.10	1.46	.144
Timeframe (linear trend)			.08	1.08	.19	.40	.690

b. **Anxiety symptoms (DASS-A) as a predictor of the likelihood of "knowing" versus "not knowing" across emotion types and timeframes, controlling for depression symptoms (DASS-D) (Study 1).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Timeframe (quadratic trend)			.17	1.18	.19	.90	.367
DASS-A × Emot (Calm vs Anxious)			**−.30**	**.74**	**.10**	**−3.07**	**.002**

Notes. DASS-A = Depression, Anxiety, and Stress Scales - Anxiety Subscale. DASS-D = Depression, Anxiety, and Stress Scales – Depression Subscale. Emot = Emotion Type. All continuous predictors were standardized prior to analyses. Significant DASS-A main effects and interactions involving DASS-A are presented in bold. All 2-way and 3-way interactions between DASS-A, Emotion Type, and Linear and Quadratic Timeframe were included in the model; however, only significant interactions (following Bonferroni correction) are reported here. Full regression statistics are available in the Online Supplement.

Table 3

***a*. Depression symptoms (DASS-D) as a predictor of the likelihood of "remembering" (versus not) across emotion types and timeframes, controlling for anxiety symptoms (DASS-A) (Study 1).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Random Effects							
Participants (N=1370)							
Intercept	1.24	1.11					
Fixed Effects							
Intercept			.53	1.70	0.07	7.17	<.001
DASS-D			**.19**	**1.21**	**0.08**	**2.38**	**.017**
DASS-A (as covariate)			.28	1.33	.05	5.23	<.001
Anxious vs Sad			.25	1.28	0.09	2.65	.008
Calm vs Sad			−.66	.52	0.09	−7.06	<.001
Happy vs Sad			.11	1.12	0.09	1.19	.232
Timeframe (linear trend)			1.19	3.29	0.18	6.44	<.001
Timeframe (quadratic trend)			−.60	.55	0.18	−3.31	<.001
DASS-D × Emot (Anxious vs Sad)			*−.18*	*.83*	*0.10*	*−1.90*	*.057*
DASS-D × Emot (Calm vs Sad)			**−.33**	**.72**	**0.09**	**−3.45**	**<.001**
DASS-D × Emot (Happy vs Sad)			**−.43**	**.65**	**0.10**	**−4.48**	**<.001**

***b*. Depression symptoms (DASS-D) as a predictor of the likelihood of "knowing" across emotion types and timeframes, controlling for anxiety symptoms (DASS-A) (Study 1).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Random Effects							
Participants (N=1378)							
Intercept	1.44	1.20					
Fixed Effects							
Intercept			.96	2.62	.08	12.42	<.001
DASS-D			.05	1.06	.08	.67	.500
DASS-A (as a covariate)			−.07	.93	.06	−1.31	.190
Anxious vs Sad			.10	1.11	.10	1.06	.287
Calm vs Sad			.39	1.47	.10	3.95	<.001
Happy vs Sad			.25	1.28	.10	2.55	.011

***b*. Depression symptoms (DASS-D) as a predictor of the likelihood of "knowing" across emotion types and timeframes, controlling for anxiety symptoms (DASS-A) (Study 1).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Timeframe (linear trend)			−.04	.96	.19	−.21	.831
Timeframe (quadratic trend)			.27	1.31	.19	1.44	.150
DASS-D × Emot (Anxious vs Sad)			−.01	.99	.09	−.12	.905
DASS-D × Emot (Calm vs Sad)			**−.31**	**.73**	**.10**	**−3.20**	**.001**
DASS-D × Emot (Happy vs Sad)			**−.21**	**.81**	**.10**	**−2.21**	**.027**

Notes. DASS-A = Depression, Anxiety, and Stress Scales - Anxiety Subscale. DASS-D = Depression, Anxiety, and Stress Scales – Depression Subscale. Emot = Emotion Type. All continuous predictors were standardized prior to analyses. Significant or marginally significant DASS-D main effects and interactions involving DASS-D (after Bonferroni correction) are presented in bold.

Table 4

a. **Anxiety symptoms (DASS-A) as a predictor of the likelihood of "remembering" versus "not remembering" across emotion types and timeframes, controlling for depression symptoms (DASS-D) (Study 2).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Random Effects							
Participants (N=1370)							
Intercept	1.22	1.10					
Fixed Effects							
Intercept			1.15	3.15	.11	10.89	<.001
DASS-A			**.64**	**1.90**	**.11**	**5.59**	**.000**
DASS-D (covariate)			−.15	.86	.07	−2.03	.042
Emot (Sad vs Anxious)			−.33	.72	.13	−2.55	.011
Emot (Calm vs Anxious)			−1.11	.33	.13	−8.61	<.001
Emot (Happy vs Anxious)			−.29	.75	.13	−2.27	.023
Timeframe (linear trend)			.63	1.88	.25	2.48	.013
Timeframe (quadratic trend)			−.33	.72	.25	−1.30	.192
DASS-A × Emot (Sad vs Anxious)			**−.34**	**.71**	**.13**	**−2.55**	**.011**
DASS-A × Emot (Happy vs Anxious)			**−.39**	**.68**	**.13**	**−2.92**	**.004**

b. **Anxiety symptoms (DASS-A) as a predictor of the likelihood of "knowing" across emotion types and timeframes, controlling for depression symptoms (DASS-D) (Study 2).**

Predictor	Variance	SD	*B*	Odds Ratio	*SE B*		*p*
Random Effects							
Participants (N=1378)							
Intercept	1.69	1.30					
Fixed Effects							
Intercept			1.76	5.81	.12	14.15	<.001
DASS-A			−.09	.92	.13	−.68	.494
DASS-D (as covariate)			−.14	.87	.09	−1.65	.100
Emot (Sad vs Anxious)			.01	1.01	.15	.06	.949
Emot (Calm vs Anxious)			.15	1.16	.15	.99	.321

b. **Anxiety symptoms (DASS-A) as a predictor of the likelihood of "knowing" across emotion types and timeframes, controlling for depression symptoms (DASS-D) (Study 2).**

Predictor	Variance	SD	*B*	Odds Ratio	*SE B*		*p*
Emot (Happy vs Anxious)			.15	1.17	.15	1.05	.292
Timeframe (linear trend)			.10	1.10	.29	.34	.734
Timeframe (quadratic trend)			.00	1.00	.29	.00	.997
DASS-A × Emot (Sad vs Anxious)			.30	1.35	.15	2.03	.042
DASS-A × Linear Timeframe			.64	1.90	.30	2.17	.030
DASS-A × Emot (Sad vs Anxious) × Linear Timeframe			−.85	.43	.38	−2.21	.027
DASS-A × Emot (Calm vs Anxious) × Linear Timeframe			**−.90**	**.41**	**.38**	**−2.35**	**.019**

c. **Anxiety symptoms (DASS-A) as a predictor of continuous "remember/know" rating response across emotion types and timeframes, controlling for depression symptoms (DASS-D) (Study 2).**

Predictor	Variance	SD	*Standardized B*	*SE B*	*df*	*t*	*p*
Random Effects							
Participants (N=798)							
Intercept	.20	.45					
Fixed Effects							
Intercept			−.09	.04	2782	−2.43	.02
DASS-A			**−.13**	**.04**	**2345**	**−3.39**	**.001**
DASS-D (covariate)			.11	.03	784	3.98	<.001
Emot (Sad vs Anxious)			−.01	.04	2347	−.19	.848
Emot (Calm vs Anxious)			.26	.04	2346	5.67	<.001
Emot (Happy vs Anxious)			.16	.04	2346	3.49	<.001
Timeframe (linear trend)			−.14	.09	2780	−1.49	.136
Timeframe (quadratic trend)			.10	.09	2781	1.16	.247
DASS-A × Emot (Sad vs Anxious)			.02	.05	2344	.44	.661
DASS-A × Emot (Calm vs Anxious)			.01	.05	2345	.17	.866
DASS-A × Emot (Happy vs Anxious)			.01	.05	2346	.13	.899
DASS-A × Linear Timeframe			**.19**	**.09**	**2770**	**2.03**	**.043**

Notes. DASS-A = Depression, Anxiety, and Stress Scales - Anxiety Subscale. DASS-D = Depression, Anxiety, and Stress Scales – Depression Subscale. Emot = Emotion Type. All continuous predictors were standardized prior to analyses. Significant and marginally significant DASS-A main effects and interactions involving DASS-A (after Bonferroni correction) are presented in bold.

Table 5

a. **Depression symptoms (DASS-D) as a predictor of the likelihood of "remembering" (versus not) across emotion types and timeframes, controlling for anxiety symptoms (DASS-A) (Study 2).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Random Effects							
Participants (N=1370)							
Intercept	1.18	1.09					
Fixed Effects							
Intercept			.84	2.31	.10	8.39	<.001
DASS-D			−.02	.98	.11	−.16	.876
DASS-A (as covariate)			.38	1.47	.07	5.17	<.001
Anxious vs Sad			.30	1.35	.13	2.33	.020
Calm vs Sad			−.81	.45	.12	−6.52	<.001
Happy vs Sad			.02	1.02	.13	.18	.856
Timeframe (linear trend)			1.20	3.31	.25	4.78	<.001
Timeframe (quadratic trend)			−.39	.68	.25	−1.58	.114
DASS-D × Emot (Happy vs Sad)			**−.31**	**.73**	**.13**	**−2.40**	**.017**

b. **Depression symptoms (DASS-D) as a predictor of the likelihood of "knowing" across emotion types and timeframes, controlling for anxiety symptoms (DASS-A) (Study 2).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Random Effects							
Participants (N=1378)							
Intercept	1.73	1.31					
Fixed Effects							
Intercept			1.76	5.84	.12	14.14	<.001
DASS-D			.06	1.07	.13	.50	.619
DASS-A (as covariate)			−.05	.95	.09	−.58	.564
Anxious vs Sad			.04	1.04	.15	.27	.786
Calm vs Sad			.15	1.16	.15	1.01	.311
Happy vs Sad			.19	1.21	.15	1.30	.193
Timeframe (linear trend)			−.51	.60	.30	−1.71	.087

b. **Depression symptoms (DASS-D) as a predictor of the likelihood of "knowing" across emotion types and timeframes, controlling for anxiety symptoms (DASS-A) (Study 2).**

Predictor	Variance	SD	*B (Log Odds)*	Odds Ratio (e^B)	*SE B*	*t*	*p*
Timeframe (quadratic trend)			.26	1.29	.29	.87	.384
DASS-D × Emot (Calm vs Sad)			**−.37**	**.69**	**.15**	**−2.44**	**.015**
DASS-D × Emot (Happy vs Sad)			**−.39**	**.68**	**.15**	**−2.56**	**.011**
DASS-D × Emot (Anxious vs Sad) × Linear Timeframe			**1.21**	**3.37**	**.39**	**3.11**	**.002**

c. **Depression symptoms (DASS-D) as a predictor of the continuous "remember/know" rating response across emotion types and timeframes, controlling for anxiety symptoms (DASS-A) (Study 2).**

Predictor	Variance	SD	*Standardized B*	*SE B*	*df*	*t*	*p*
Random Effects							
Participants (N=798)							
Intercept	.20	.45					
Fixed Effects							
Intercept			−.10	.04	2780	−2.73	.01
DASS-D			**.12**	**.04**	**2340**	**2.98**	**.003**
DASS-A (as covariate)			−.11	.03	784.7	−4.04	<.001
Emot (Anxious vs Sad)			.01	.04	2347	.13	.900
Emot (Calm vs Sad)			.27	.04	2348	6.01	<.001
Emot (Happy vs Sad)			.17	.04	2347	3.73	<.001
Timeframe (linear trend)			−.34	.09	2782	−3.74	<.001
Timeframe (quadratic trend)			.18	.09	2774	2.07	.039

Notes. DASS-A = Depression, Anxiety, and Stress Scales - Anxiety Subscale. DASS-D = Depression, Anxiety, and Stress Scales – Depression Subscale. Emot = Emotion Type. All continuous predictors were standardized prior to analyses. Significant or marginally significant DASS-D main effects and interactions involving DASS-D (after Bonferroni correction) are presented in bold.