American Psychological Association

Journal of Personality and Social Psychology:
Personality Processes and Individual Differences

0022-3514/18/$12.00

2018, Vol. 115, No. 4, 688–715
http://dx.doi.org/10.1037/pspp0000215

PERSONALITY PROCESSES AND INDIVIDUAL DIFFERENCES

Does Attachment Anxiety Promote the Encoding of False Memories? An Investigation of the Processes Linking Adult Attachment to Memory Errors

Nathan W. Hudson
Southern Methodist University

R. Chris Fraley
University of Illinois at Urbana-Champaign

Previous research has suggested that people's attachment styles influence memory processes. Most of this work has focused on the encoding and retrieval of information about events that actually took place. The purpose of the present research was to determine (a) whether attachment styles also predict memories for events that never occurred (false memories); (b) whether experimentally induced attachment anxiety leads to the generation of false memories for interpersonal experiences; and (c) whether these errors arise during encoding, maintenance, or retrieval processes. Our results indicated that attachment anxiety is associated with people's propensities to experience false alarms on recognition tasks for relational stimuli. Moreover, experimentally altering participants' state levels of attachment anxiety led to more numerous false alarms, as compared with an unprimed control group. These findings are consistent with the idea that attachment-related anxiety might selectively bias and desensitize the encoding of interpersonal events, ultimately leading people to remember events that did not occur. However, experimentally priming anxiety did not lead to more false alarms relative to groups primed with security, raising the possibility that the anxiety-false memory association could be because of making relational issues salient rather than increasing attachment anxiety per se.

Keywords: adult attachment, false memories, personality processes

Relationship partners sometimes disagree about what happened during their previous interactions. Perhaps one person believes that a promise was made and broken—yet their partner has no recollection of the alleged obligation. Alternatively, one individual may feel slighted by a perceived insult from their partner—yet the partner insists that the offensive remark was never uttered.

How is it possible for two people to recall a shared experience in such irreconcilable ways? One possibility is that the allegedly offending partner simply forgot the broken promise or the distasteful comment. Indeed, researchers have found that people's attachment styles predict these types of *errors of omission*. Specifically, people with high levels of attachment avoidance are more likely than their less-avoidant peers both (a) to defensively direct their attention away from relationally relevant stimuli and, therefore, fail to encode them into memory (Edelstein et al., 2005; Fraley & Brumbaugh, 2007; Fraley, Garner, & Shaver, 2000); and (b) to actively suppress recalling relational information that has successfully eked past their defenses and into their memories (e.g., Pereg & Mikulincer, 2004).

However, when two partners disagree about who said what to whom; it may also be the case that no one has forgotten anything. Rather, it is also possible that the offended partner "remembered" an incident that never occurred (e.g., Jou & Flores, 2013; Loftus & Pickrell, 1995). Although people's attachment styles have been shown to predict their propensities to fail to remember certain types of stimuli—memory errors of omission—few studies have examined how attachment orientations might relate to memory *errors of commission*, including false memories (cf. Ein-Dor, Mikulincer, & Shaver, 2011).

The present research was designed to advance our understanding of how adult attachment styles are related to the generation of false memories. In Studies 1 and 2, we examined the extent to which people's attachment styles correlate with their propensities to experience false memories for relational information during a recognition memory test. After establishing that anxious attachment is related to false memories, we next examined whether manipulating state-level attachment anxiety leads people to falsely remember relational events that never occurred while completing a recognition memory task (Studies 3–5). Importantly, we systematically varied the timing of attachment anxiety inductions to

Nathan W. Hudson, Department of Psychology, Southern Methodist University; R. Chris Fraley, Department of Psychology, University of Illinois at Urbana-Champaign.

This research was supported by a Heritage Dissertation Grant Award from the Foundation for Personality and Social Psychology, as well as a Dissertation Completion Fellowship from the University of Illinois at Urbana-Champaign Graduate College. We thank Aaron S. Benjamin, Dov Cohen, Jaime L. Derringer, and Michael W. Kraus for their invaluable advice and feedback on these studies.

Correspondence concerning this article should be addressed to Nathan W. Hudson, Department of Psychology, Southern Methodist University, P.O. Box 750442, Dallas, TX 75275. E-mail: nwhudson@smu.edu

isolate the processes that may underlie the generation of attachment-driven false memories.

Individual Differences in Attachment and Memory

People vary considerably in the ways they think, feel, and behave in their close relationships. Some people, for example are relatively secure in the way they relate to others; they assume others will be available when needed, and are comfortable venturing out into the world with the knowledge that others support them. Other people, in contrast, are relatively insecure in the way they relate to others. They may question whether others will not be there for them when needed. As a result, they might be relatively anxious in their attachment orientation—preoccupied with relationships and vigilant to signs of rejection and acceptance. Alternatively, they may push others away and try to avoid intimacy. In the social-personality literature, these individual differences are often referred to as *attachment styles* or *attachment orientations* and are typically conceptualized as varying along two distinct dimensions labeled *attachment anxiety* and *attachment avoidance* (Brennan, Clark, & Shaver, 1998; Fraley, Waller, & Brennan, 2000), with prototypically secure people scoring low on both. Individual differences in attachment anxiety and avoidance are thought to arise from individuals' *working models*—beliefs and expectations regarding the nature of close relationships. Decades of research have demonstrated that attachment anxiety and avoidance are related to a wide array of psychological and interpersonal outcomes, including close relationship functioning, depression and well-being, and emotion regulation (Gillath, Karantzas, & Fraley, 2016; Mikulincer & Shaver, 2016).

One of the core themes in modern attachment research concerns the ways in which memory processes operate as a function of attachment orientations. This work has been valuable because individual differences in attachment are largely assumed to be because of the ways in which people encode and mentally represent their interpersonal experiences (Collins, Guichard, Ford, & Feeney, 2004). One of the salient findings in this literature is that highly avoidant individuals have difficulty remembering relationship-relevant information—both childhood memories (Edelstein et al., 2005; Haggerty, Siefert, & Weinberger, 2010; Kohn, Rholes, & Schmeichel, 2012; Mikulincer & Orbach, 1995) and memories for stimuli presented in the lab (Edelstein, 2006; Fraley & Brumbaugh, 2007; Fraley, Garner, et al., 2000; Goodman et al., 2011; Miller, 2001; Zeijlmans van Emmichoven, van Ijzendoorn, De Ruiter, & Brosschot, 2003). These findings suggest that people high in attachment avoidance direct their attention away from relationship-relevant stimuli and fail to encode them into memory (and, thus, there are fewer memories to retrieve; Edelstein, 2006; Fraley & Brumbaugh, 2007).

In addition to these errors of omission, attachment orientations might also predict errors of commission, such as falsely remembering events that never occurred. For example, people with high levels of attachment anxiety may be more likely to encode or reconstruct a greater number of false relationally relevant memories, perhaps through perceptual biases in encoding (e.g., Pereg & Mikulincer, 2004) or source memory confusion at the point of memory retrieval (Johnson, Hashtroudi, & Lindsay, 1993; Straube, 2012). However, only a small number of studies have examined how attachment relates to false memories, and those studies have produced mixed findings. For example, in two studies (*N*s = 69 and 57) designed to examine people's threat-response strategies, Ein-Dor and colleagues (2011) found that both attachment anxiety and avoidance predicted false memories on recognition tasks. However, across two larger studies (*N*s = 302 and 368) directly designed to assess links between attachment styles and false memories, Wilson (2006) found mixed evidence suggesting that perhaps only attachment anxiety predicts false memories.

In a different study ($N = 213$), participants read a fictitious account of childhood sexual abuse (McWilliams, Goodman, Lyons, Newton, & Avila-Mora, 2014). In a subsequent session, they were asked several cued-recall questions. Both highly anxious (with respect to attachment) and highly avoidant individuals provided fewer correct answers. However, individuals who were highly anxious with respect to attachment also provided greater numbers of *incorrect* or *false* details pertaining to the events from the story. Although this study was not directly designed to assess participants' susceptibility to experiencing false memories, its findings suggest a link between attachment anxiety and false memories.[1]

In summary, the existing empirical literature provides an unclear picture of the extent to which individual differences in attachment styles are related to false memories. Although several studies seem to tentatively converge on the idea that attachment anxiety predicts false memories, the evidence remains inconclusive (Ein-Dor et al., 2011; McWilliams et al., 2014; Wilson, 2006). Therefore, the first goal of the studies presented here was to use highly powered designs to examine the extent to which people's levels of attachment anxiety and avoidance correlate with their propensity to experience false memories in the context of a recognition paradigm. In three subsequent studies, we used experimental methods to temporarily manipulate people's attachment styles to examine whether attachment anxiety causes false memories during recognition tasks—and where in the cognitive chain of events it does so.

A Model of Attachment and False Memory Susceptibility

Why might we expect attachment styles—and anxious attachment, in particular—to promote false memories? Speaking broadly, memory consists of at least three stages: encoding, maintenance, and retrieval. Errors in any of these stages can produce false memories (Straube, 2012). Figure 1 illustrates several ways in which attachment styles might be expected to interface with memory processes to cause false memories. Specifically, people's attachment styles might influence any or all of the stages of memory, potentially injecting false memories at any stage. We will discuss each stage separately.

Encoding

Information about experiences is encoded at various levels of specificity. For any given experience, the mind is thought to create *verbatim traces* that store specific "surface" details about the

[1] Other studies have found that more general *social* anxiety and avoidance (or other individual differences) are related to memory suggestibility—false memories that occur based on information introduced after the experience in question (Clancy, McNally, Schacter, Lenzenweger, & Pitman, 2002; Wright, Busnello, Buratto, & Stein, 2012; Wright, London, & Waechter, 2010).

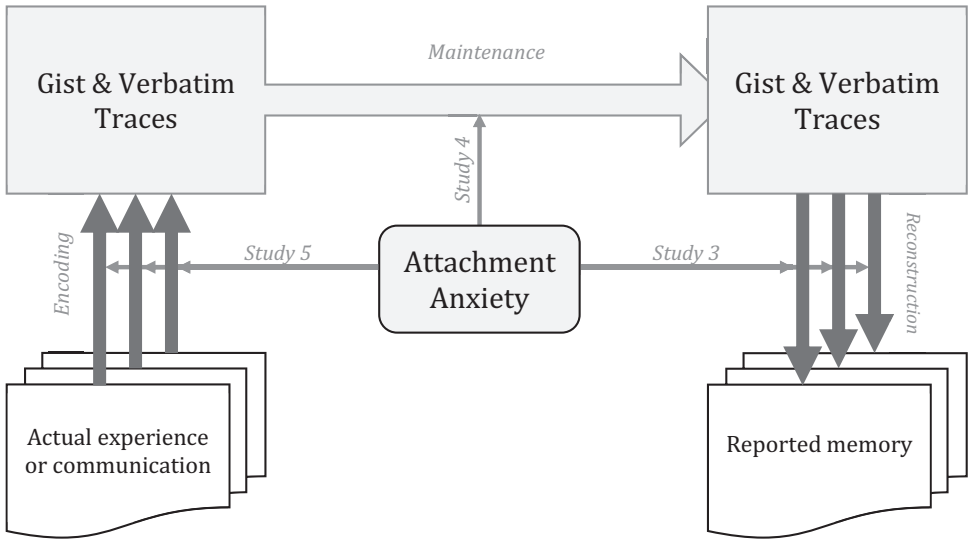

Figure 1. Theoretical model of the influence of the attachment system on false memories.

experience (Brainerd & Reyna, 2002; Straube, 2012). Additionally, the mind is also thought to create "fuzzier" *gist traces* that capture the individuals' interpretations of experiences (including meaning, patterns, and associations)—and these gist traces are thought to be susceptible to the effects of spreading activation at the time of memory creation (Brainerd & Reyna, 2002; Straube, 2012). As a concrete example, studies using the Deese-Roediger-McDermott (DRM) paradigm present participants with lists of words that have a common theme. For example, the list of words, *bed*, *rest*, *awake*, *tired*, *dream*, *wake*, *snooze*, *blanket*, *doze*, *slumber*, *snore*, *nap*, *peace*, *yawn*, and *drowsy* all relate to the theme of *sleep*, although the word "sleep" is surreptitiously absent from the list. Nevertheless, if participants are presented with those 15 words and asked to free-recall the words they saw, about 60% will falsely remember that the word sleep was present (Stadler, Roediger, & McDermott, 1999). This effect is thought to occur because the mind creates verbatim traces for the words *actually* on the list, as well as a gist trace that captures the thematic content of the words. At the point of recall, the gist trace may produce a signal that is equally as compelling as those produced by the verbatim traces (Brainerd & Reyna, 2002), creating a strong subjective experience that the word sleep was, in fact, on the list.

Attachment orientations may have the potential to shape encoding processes, thereby biasing the mind to recall events that never happened. For example, individuals who are highly anxious with respect to attachment tend to be *preoccupied* with their relationships (Bartholomew & Horowitz, 1991; Hazan & Shaver, 1987). In other words, highly attachment-anxious individuals frequently ruminate and reflect upon their relationships. This chronic mental activation of relational themes (e.g., rejection) may directly affect the meaning and interpretation that individuals who are highly anxious with respect to attachment ascribe to their interpersonal interactions. Thus, people with high levels of attachment anxiety may encode gist traces containing qualitatively different content than those encoded by their more secure peers. For instance, highly anxious people perceive interpersonal interactions and others' motives more negatively (Collins et al., 2004; Pereg & Mikulincer, 2004)—biases that may influence the encoding of gist traces and spur false memories. Moreover, similar to the DRM phenomenon, relational concerns that are active in highly anxious individuals' minds at the time memories are created may be encoded alongside the actual events that occurred, later producing false memories.

People's attachment orientations may also affect which details they attend to and, thus, encode into verbatim traces. For example, previous research suggests that highly avoidant individuals may fail to attend to (and, thus, also fail to encode) details that pertain to relational stimuli (Edelstein, 2006; Fraley & Brumbaugh, 2007; Fraley, Garner, et al., 2000). In a similar vein, individuals with high levels of attachment anxiety may selectively focus their attention toward rejection- or emotion-related information (Chris Fraley, Niedenthal, Marks, Brumbaugh, & Vicary, 2006), and thereby fail to encode other details. This process alone might bias highly anxious individuals' memories such that their recollections of events are more permeated with emotions or cues suggestive of rejection, as compared with relatively secure individuals' memories for the same events. Moreover, encoding fewer or poorer-quality verbatim traces may force insecurely attached individuals to rely more on gist traces during retrieval, potentially leading to retrieval of false information that is consistent with the gist traces (Brainerd & Reyna, 2002).

To summarize, insecurely attached individuals may encode fewer verbatim traces, forcing them to rely more upon gist traces upon retrieval, selectively encode verbatim traces that pertain to emotions and rejection, and/or encode gist traces containing qualitatively different content than do their more secure peers. The net result of any of these processes could be the generation of false memories, as manifested upon retrieval.

Maintenance

False memories can also be created during memory maintenance processes—through both interference and consolidation (Straube, 2012). With respect to interference, old memory traces can be corrupted when new memories are encoded (Loftus & Palmer,

1974; Wright & Loftus, 1998; Zaragoza, Mitchell, Payment, & Drivdahl, 2011). For example, in a famous experiment, Loftus and Palmer (1974) showed participants a video of two automobiles colliding, in which no glass was shattered. In follow-up questions, they asked some participants about the events that occurred when the cars "smashed;" other participants were asked what happened when the cars "collided" or "bumped." One word—smashed—was enough to corrupt participants' existing memory traces, causing them to falsely remember seeing shattered glass in the video when asked in a follow-up session one week later.

With respect to consolidation, even in the absence of nefarious experimenter intervention, natural memory consolidation processes—such as those that occur while sleeping—can create false memories when new memories are reorganized, consolidated, and linked to existing memories (Straube, 2012; Wagner, Gais, Haider, Verleger, & Born, 2004).

As depicted in Figure 1, people's attachment orientations might be expected to affect the maintenance of memory traces over time. People with insecure attachment styles may be especially likely to corrupt or bias relationally relevant memory traces. Supporting this idea, a growing body of literature suggests that insecurely attached individuals' emotional evaluations of interpersonal experiences become negatively biased over time. Several different studies have asked participants to engage in a discussion with their parents (Dykas, Woodhouse, Ehrlich, & Cassidy, 2010), peers (Dykas, Woodhouse, Ehrlich, & Cassidy, 2012; Feeney & Cassidy, 2003), romantic partners (Simpson, Rholes, & Winterheld, 2010), or even therapists (Woodhouse & Gelso, 2008), and subsequently rate their emotional evaluations of the interaction both immediately and after a delay (ranging from days to months). These studies all converge on the finding that people with high levels of attachment anxiety and/or avoidance rate the experiences more negatively after a time delay than they do immediately after the interaction. Although these studies did not examine false memories per se (but rather general emotional evaluations), their findings are consistent with the notion that, during memory consolidation processes, individuals high in attachment anxiety or avoidance bias their memory traces to include more negativity. To the extent that gist traces are negatively biased over time, or verbatim traces are corrupted through interference, individuals may construct false memories upon retrieval.

Retrieval

Finally, false memories can also be generated during memory retrieval processes—in both free-recall and recognition paradigms (Straube, 2012). Specifically, people's intrapersonal and external circumstances can affect which memory traces are available and active during retrieval (Dell, 1986). Straube (2012) argued that this can produce source memory confusion (Johnson et al., 1993), leaving people with the difficult task of discerning which memory traces are active because of extraneous factors, such as spreading activation, and which are directly relevant to the memory being retrieved.

As depicted in Figure 1, people's attachment orientations might also be expected to influence how they reconstruct the specific details of remembered experiences from their verbatim and gist traces. Why? First, spreading activation from feelings of insecurity at the time of memory retrieval may bias individuals who are anxious with respect to attachment toward remembering false, insecurity-related events. Second, even assuming equivalent gist traces, insecure individuals may be biased toward constructing more negative details from those gist traces and, thus, endorsing a greater number of false memories. Of course, these possibilities are not mutually exclusive, and could potentially both contribute to generation of false memories during retrieval.

Overview of the Present Studies

The present research had two major goals. Our first objective was to determine whether attachment styles are related to people's propensities to experience false relational memories during recognition tasks. As we report, Studies 1 and 2 found that people high in attachment anxiety were more likely than their less-anxious peers to falsely recognize relational information that was not, in fact, presented among the memory stimuli. Our second major goal was to determine whether attachment anxiety plays a causal role in false memory production. Therefore, in Studies 3–5, we experimentally manipulated participants' state-level attachment anxiety to determine whether doing so induced subsequent false memories on a recognition task. In addition, we systematically investigated whether attachment anxiety leads to false memories by operating on encoding, maintenance, and/or retrieval processes. Specifically, by manipulating participants' state-level attachment styles during various stages in the memory process (depicted in Figure 1), we attempted to identify *where* in the cognitive chain of events attachment anxiety shapes memory processes.

Study 1

Study 1 was designed to examine the extent to which people's attachment styles predict their propensity to experience false memories in the context of a "new/old" recognition task. Participants were presented with a list of relationally relevant words and subsequently completed a recognition memory test containing a mixture of "old" items that had been previously studied, as well as new items that were not included in the original memory stimuli list. These data were used to examine the associations between attachment styles and false alarms (i.e., false memories; believing new items were previously seen) on the memory test.

Method

All studies were conducted under the University of Illinois at Urbana-Champaign Institutional Review Board protocols 13,779 ("attachment and memory") and 12,591 ("attachment and defensive social processes").

Participants. Study 1 was posted to the first author's website, www.PersonalityAssessor.com. People can find Personality Assessor via internet searchers (e.g., "free personality tests"), social media, or links from other websites. Personality Assessor's users complete studies as a recreational/leisure activity to obtain feedback about themselves. Study 1 was advertised as a "free personality test" that allowed users to "learn how [their] personality relates to [their] memory ability." A total of 379 participants completed the study.

Before any analyses, we excluded data from 43 participants because they (a) were under 18 years of age, (b) indicated that they

had cheated during the memory task,[2] and/or (c) took longer than 30 minutes to complete the study.[3] The final sample size of 336 people afforded approximately 97% power to detect average-sized effects (equivalent to $r = .21$; Richard, Bond, & Stokes-Zoota, 2003), and approximately 80% power to detect zero-order effects as small as $r = .15$.[4] The final sample was predominantly (77%) female, and ages ranged from 18 to 63 ($M = 30.93$, $SD = 12.09$). Participants were instructed to nominate all racial or ethnic groups with which they identified: 61% of the sample identified as White, 19% as Asian, 9% as Indian (Asian), 6% as Black, 4% as Hispanic, 3% as Middle Eastern, 2% as Native American, and 2% as Pacific Islander. Forty-two percent of the sample indicated that they were currently single, 23% indicated that they were married, and 24% indicated that they were in a committed nonmarital romantic relationship.

Measures.

Attachment orientations. Participants' attachment styles were assessed using the 12-item Experiences in Close Relationships Short Form (ECR-S; Wei, Russell, Mallinckrodt, & Vogel, 2007). The ECR-S contains subscales for attachment anxiety (e.g., "I often worry that my romantic partner doesn't really care for me") and attachment avoidance (e.g., "I prefer not to show my romantic partner how I feel deep down"). All items were rated using a Likert scale running from *strongly disagree* (1) to *strongly agree* (5). Items were averaged to form composites for general-romantic attachment anxiety ($\alpha = .70$) and avoidance ($\alpha = .78$). A prototypically "secure" individual is low in both attachment anxiety and avoidance.

Procedure. Participants first provided basic demographic information and self-report ratings of their attachment anxiety and avoidance. Subsequently, they completed two separate recognition memory tests. Before administration of the tests, participants were instructed that they would see two lists of words—and that they would be asked to remember as many of the words as possible. Participants were asked to not record the words in any way—but rather to attempt to recognize the words from memory alone.

For each memory test, participants were presented with a list of 18 relationship-relevant words (e.g., abandoned, clingy, comfortable, and independent).[5] Each word was presented individually in large font in the center of the browser window for exactly 2 s. The order of the words was fully randomized per participant. Immediately after seeing the list of words, participants completed a recognition task. Specifically, participants were presented with 26 words, one at a time, and were asked to indicate whether they saw each word in the prior stimuli list, using a binary "*yes*" (1) or "*no*" (0) scale. All 18 words from the stimuli list were included in the memory test, in addition to 8 new words that were not in the original stimuli list. The order of the memory test items was fully randomized per participant.

Immediately after completing the first memory task, participants were presented with a second memory task—which used identical procedures (i.e., participants saw a list of 18 new words and then completed a new 26-item recognition memory test). The stimuli and test items were fully mutually exclusive across the two memory tests. Thus, across both memory tests, participants were asked to rate a total of 52 memory items—36 words they had seen during the memory tests, and 16 that they had not. All of our primary analyses focused on participants' *false alarm rates* (i.e., incorrectly indicating that they had previously seen new words) and *hit rates* (i.e., rate of correctly identifying words that had been presented). After completing both memory tasks, participants were provided with a personalized results web page that summarized their attachment style and performance on the memory tests.

Results and Discussion

Analysis strategy. At first glance, it might seem that the most parsimonious way to analyze our data would be to simply correlate false alarm rates with people's attachment styles. However, such an analysis is suboptimal, as it omits critical information pertinent to *why* attachment might correlate with false memories. Specifically, from a signal detection theory (SDT) perspective (e.g., Macmillan & Creelman, 1991), false memories can arise as the result of at least two distinct processes: *bias* and (*in*)*sensitivity*.[6] Bias measures the extent to which individuals are more or less likely to believe that *any* memory test item is true—and it is typically operationalized as a *sum* and/or *average* of the hit rate and false alarm rate (i.e., the overall endorsement rate). Sensitivity refers to the extent that an individual is able to accurately differentiate true items from false ones—and it is typically operationalized as a type of *difference* between the hit rate and false alarm rate (henceforth, we use the term *insensitivity* as a synonym for "low sensitivity").[7] Although there is not a one-to-one correspondence between bias and sensitivity and particular cognitive processes, the presence of bias and/or insensitivity can potentially help elucidate the processes through which attachment anxiety is linked to false memories.

With respect to memory *bias*, it is possible that high levels of attachment anxiety, for example, lead people to believe that essentially any relationally relevant information was present. Con-

[2] After completing the study, participants were asked, in a nonconfrontational way, "Did you just recall the words from memory? Or did you record the words somewhere else in order to remember them? It's okay if you recorded the words somewhere, we just want to know." Participants who indicated that they had recorded the words were excluded from analyses.

[3] Unlike lab participants, online participants can take extended breaks while completing studies. On average, included participants took 9.36 minutes to complete the study ($SD = 2.70$). Excluded participants—who had an average completion time of 2.55 *hours*—likely did not complete the study in a single setting, which may compromise their data in unexpected ways.

[4] Study 1 used multilevel logistic regression. The multilevel nature of the data enables greater statistical power. However, computing power for multilevel models requires information regarding, for example, the percent of variance in the outcome that is within versus between persons. As we had no basis for estimating these priors in Study 1, we based our power analyses on the sample size needed to detect an average zero-order effect.

[5] Importantly, across all five studies, we examined the extent to which attachment might predict false memories specifically in relational contexts. There were two reasons for this choice. First, as outlined above, we would expect attachment to spur false memories via cognitive processes that pertain specifically to relationships (e.g., anxious individuals may experience false memories because they "confuse" their chronically activated relational concerns with memories of real relational events). Second, previous research examining attachment and forgetting has found that attachment styles are only correlated with memory impairments for relational stimuli (Edelstein, 2006).

[6] Sensitivity is sometimes referred to as "accuracy" or "diagnosticity."

[7] One common operationalization of sensitivity is z(hit rate) – z(false alarm rate). Another common operationalization is the relative log-odds of endorsing true items over false ones (as in our studies).

sequently, people with highly biased memories would be likely to remember greater numbers of both false and true relational items. The presence of bias may indicate that processes similar to source memory confusion—mistakenly attributing chronically activated insecurity as being relevant to the memory being retrieved—contribute to false memories (Straube, 2012).

In contrast, with respect to memory *insensitivity*, it is possible that high levels of attachment anxiety, for example, interfere with people's abilities to encode, maintain, and/or retrieve accurate and detailed memory traces. In the absence of high-quality information, highly anxious individuals may be forced to essentially "guess" what happened when attempting to remember specific events. (Notably, this guesswork may be entirely transparent to them, and their memories of the events in question may seem quite subjectively compelling; see Brainerd & Reyna, 2002.) As a result, people with highly insensitive memories would be likely to "remember" more numerous false items and fail to remember more of the true ones. The presence of insensitivity might indicate that processes similar to selective and/or narrowed attention (Fraley & Brumbaugh, 2007; Chris Fraley et al., 2006) contribute to false memories.

To compute the effects of bias and insensitivity, it is necessary to model the effects of attachment on *both* false alarm rates and hit rates simultaneously (Macmillan & Creelman, 1991). Therefore, all analyses examining false alarms were conducted using multilevel logistic models (MLLMs).[8] In these analyses, we modeled participants' log-transformed odds of *endorsing* individual items in the memory test *as having occurred* as a function of whether the item was true or false (dummy coded: 1 = true, 0 = false) and the participant's standardized trait-levels of attachment anxiety and avoidance. (To be clear, the dependent variable modeled was participants' *odds of endorsing items as having occurred*; it was *not* participants' odds of *correctly* identifying items as true or false.) As a concrete example, a simplified version of one MLLM used across all five studies that models the log-odds of person, *j*, endorsing item, *i,* is:

$$\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = b_0 + b_1(true)_{ij} + b_2(attachment\ anxiety)_j + b_3(attachment\ anxiety)_j\,(true)_{ij} + U_j$$

In this model, $\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right)$ represents the log-odd transformed probability of endorsing items as having occurred, *true* represents whether an item was present (1) or absent (0) in the original study set, *attachment anxiety* represents individuals' standardized attachment anxiety scores, and *U* represents a random intercept for participants (see footnote 9 for this equation in HLM notation).[9] Thus, the b_1 term (for the "true" variable) provides an estimate of the extent to which participants *with average levels of attachment anxiety* endorsed true items at a greater frequency than false ones. We expected a *positive* b_1 parameter in all analyses, indicating that average participants' *hit rates* (i.e., endorsement of true items) were higher than their *false alarm rates* (i.e., endorsement of false items).

The b_2 term provides an estimate of the extent to which higher levels of attachment anxiety predicted higher *false alarm rates.* Namely, when an interaction is included in a regression, the lower-order terms represent simple slopes when all other relevant variables in the model are held constant at zero. Because the true variable is dummy-coded with "false" as the reference group (0 = false, 1 = true), b_2 represents the simple effect of anxiety when the true variable is zero (i.e., for false items). Thus, for example, a positive b_2 coefficient would indicate that people with high levels of attachment anxiety experienced more numerous false alarms, as compared with their more secure (i.e., less anxious) peers.[10]

Finally, the b_3 interaction term provides an estimate of the extent to which the item being true—as opposed to false—moderated the association between attachment anxiety and item endorsement. Stated more simply, the b_3 coefficient indicates the extent to which attachment anxiety had a *different* association with hit rates, *relative to* its association with false alarm rates (i.e., b_2). As a result, the simple coefficient for attachment anxiety predicting *hit rates* is $b_2 + b_3$. For example, if $b_2 = 0.20$ and $b_3 = -0.20$, this pattern of results would indicate that attachment anxiety was associated with higher *false alarm rates* ($b_2 = 0.20$, odds ratio [OR] = 1.22), but had absolutely no relationship with *hit rates* ($b_2 + b_3 = 0.20 - 0.20 = 0.00$, OR = 1.00).[11]

Given these features of this MLLM, the b_2 and b_3 coefficients can be used together to test the hypothesis that high levels of attachment anxiety predict false memories, in addition to exploring the roles of bias and insensitivity. A positive b_2 coefficient would indicate that high levels of attachment anxiety predict false memories. Assuming that the b_2 coefficient is, in fact, positive, the b_3 interaction term can be used to elucidate whether these false memories result from bias and/or insensitivity in people's memories.

Specifically, the b_1 term (for the true variable) is a measure of sensitivity (the extent to which hit rate is higher than false alarm rate), as it captures the relative difference in participants' log-odds of endorsing true versus false items. The b_3 interaction term captures the extent to which sensitivity varies (i.e., increases or decreases) as a function of attachment anxiety. Finally, with respect to bias, the association between attachment anxiety and bias is represented by a combination of the b_2 and b_3 coefficients, such that b_2 represents the association between attachment anxiety and false alarm rates, and the sum of b_2 and b_3 represents the association between attachment anxiety and hit rates. Consequently, the association between attachment anxiety and the nonweighted average endorsement of items (i.e., bias, as typically conceptualized in the signal detection literature) is $b_2 + [1/2]b_3$. Individual differences in bias not accounted for other terms in the model are modeled (and controlled) by the random intercept for persons (U_j).

Figure 2 illustrates three hypothetical patterns of results with equivalent b_2 coefficients, but where varying b_3 coefficients indicate the presence of bias effects, insensitivity effects, or both. First,

[8] Analyses were conducted using SPSS's genlinmixed function with a logit link and binomial distribution.

[9] The model presented in-text is the linear mixed model. This model can also be written as a hierarchical linear model. In this case, the Level 1 equation would be $y = b_{0j} + b_{1j}(\text{true})_i$, and the Level 2 equations would be $b_{0j} = g_{00} + g_{01}(\text{anxiety})_j + U_j$ and $b_{1j} = g_{10} + g_{11}(\text{anxiety})_j$.

[10] For false items, the MLLM presented in the main text simplifies to $\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = b_0 + b_2(attachment\ anxiety)_j + U_j$. For true items, the MLLM can be arranged as $\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = (b_0 + b_1) + (b_2 + b_3)\,(attachment\ anxiety)_j + U_j$.

[11] Per reviewers' requests, we also examined cross-classified models that included random intercepts for memory test items in addition to random intercepts for persons. These models produced similar parameter estimates to those reported in the text, and did not change the statistical significance of any parameter estimate in any study.

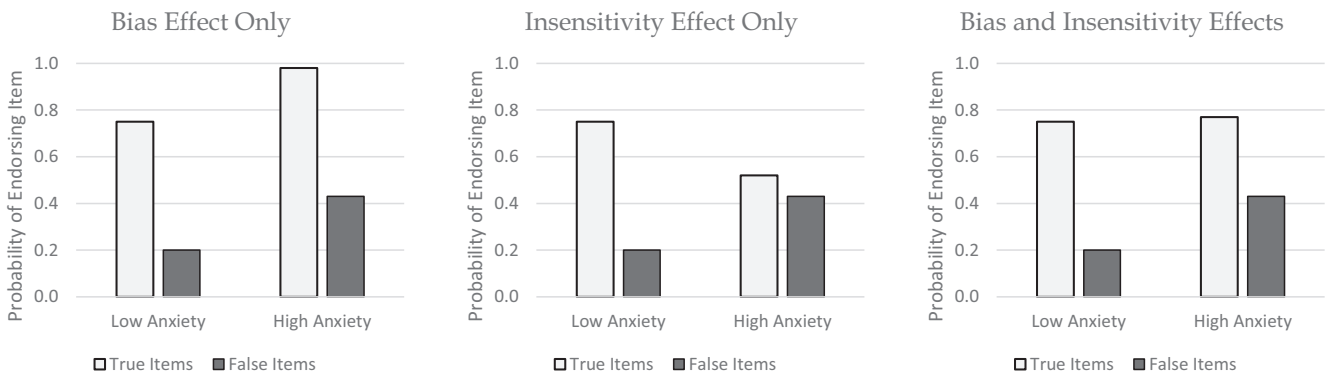

Figure 2. Illustration of how bias and insensitivity effects may manifest in the interaction between attachment anxiety and item-veracity in predicting endorsement of false and true items. Across all three panels, the simple effect of attachment anxiety on false items (b_2) is positive. In the left hand *bias-only* panel, the *Anxiety* × *True* interaction term is zero ($b_3 = 0$), indicating that anxiety has the same association with true and false items. In the center *insensitivity-only* panel, the *Anxiety* × *True* interaction term, b_3, equals $-2b_2$, indicating that anxiety has *opposite* associations with true and false items. In the right-hand panel depicting both bias and insensitivity effects, the *Anxiety* × *True* interaction term, b_3, equals $-b_2$, indicating that anxiety has *no* simple association with true items (i.e., the simple association of anxiety with true items $= b_2 + b_3 = 0$).

as can be seen in the left-hand panel of Figure 2, to the extent that high levels of attachment anxiety *bias* memory (i.e., lower the threshold for believing that an item was, in fact, previously seen) but do not affect memory sensitivity (i.e., ability to discern true and false information), we should expect a simple association between attachment anxiety and false alarms, but no interaction between attachment anxiety and item-veracity ($b_3 \cong 0$; indicating that the simple association between attachment anxiety and hit rates was identical to the simple association between attachment anxiety and false alarms). Such a finding would indicate that people with high levels of attachment anxiety are more likely to experience false memories because they have lower thresholds for what they are willing to endorse as having actually taken place. This, in turn, causes people to endorse both true and false items at a greater rate than do their peers with lower levels of attachment anxiety.

Second, as depicted in the center panel of Figure 2, to the extent that high levels of attachment anxiety reduce memory sensitivity but do not affect bias, we should expect no main effect of attachment anxiety, but should expect a *negative* interaction between attachment anxiety and item-veracity (for this situation to occur, the b_3 coefficient must be roughly twice the absolute magnitude of the b_2 coefficient, but in the opposite direction). Such an interaction would indicate that attachment anxiety interferes with people's abilities to correctly remember events, which essentially causes them to rely more upon "guesses" about what happened while reconstructing memories.[12] The natural consequence is that both hit rates and false alarm rates will be pressed toward the guessing rate, which would result in a *decrease* in hit rates, and an *increase* in false alarm rates. Such a finding might indicate that individuals with high levels of attachment anxiety are likely to falsely remember events that never occurred simply because their ability to accurately remember events is inhibited; and, as a result, when reconstructing memories, they are guessing more about what occurred (and potentially relying more on gist traces than verbatim ones).

Finally, it is possible that attachment anxiety might both increase bias *and* reduce the sensitivity of people's memories. As depicted in the right-hand panel of Figure 2, to the extent that attachment anxiety both biases and desensitizes people's memories, we should expect a main effect of attachment anxiety, and a negative interaction between attachment anxiety and item-veracity (b_3), such that attachment anxiety is especially associated with increased endorsement of *false* items in particular (for this situation to occur, the b_3 coefficient must be negative, but significantly less than twice the absolute magnitude of the b_2 coefficient). Such a finding would indicate that high levels of attachment anxiety are associated with lower memory sensitivity/accuracy (potentially forcing people to guess more about what happened when reconstructing memories), and also with greater bias to "remember" more relationally relevant stimuli (i.e., lower thresholds for believing that items are, in fact, remembered), leading people to experience false memories. Notably, in this situation, because insensitivity *lowers* hit rates and bias *increases* hit rates, it is possible for these effects to mutually cancel and create a situation in which attachment anxiety appears to have no correlation with hit rates.

Correlations between attachment orientations and memory. We first examined the associations between attachment anxiety and memory ability. To do so, we used the MLLM described in the Analysis Strategy section above. As can be seen in Table 1, there was an interaction between attachment anxiety and item-veracity ($OR_{true \times anxiety} = 0.89$, 95% confidence interval, CI [0.82, 0.95]), such that attachment anxiety was correlated with false alarm rates (simple $OR_{anxiety} = 1.12$, 95% CI [1.02, 1.21]) but not hit rates (simple $OR_{attachment\text{-}anxiety} = 0.99$, 95% CI [0.91, 1.07]).

The parameter estimates in Table 1 can be used to obtain model-predicted log-odds of endorsing true and false items for

[12] As aforementioned, this "guesswork" may be entirely transparent to people; their memories for the events may seem quite subjectively compelling to them (Brainerd & Reyna, 2002).

Table 1
Study 1 MLLM Predicting Odds of Endorsing True and False Items on the Memory Quiz From Standardized Global-Romantic Attachment Anxiety

Predictor	*b*	Odds ratio	95% CI LB	95% CI UB
Intercept	−.53	—	—	—
Item true	**2.18**	**8.82**	8.17	9.51
Trait anxiety[a]	**.11**	**1.12**	1.02	1.21
Item True × Trait Anxiety	**−.12**	**.89**	.82	.95

Note. MLLM = multilevel logistic model; CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00.
[a] Because the "item true" variable was dummy coded (0 = false, 1 = true), this is the simple effect of anxiety on *false* items.

persons with varying levels of attachment anxiety. These somewhat opaque and difficult-to-interpret model-predicted log-odds can be transformed into easily interpretable model-predicted probabilities of endorsing true and false items (i.e., hit rates and false alarm rates, respectively). As depicted in Figure 3, the model-predicted false alarm rate for people low (1 *SD* below the mean) in attachment anxiety was 35% (95% CI [32%, 37%]). In contrast, people high (1 *SD* above the mean) in attachment anxiety were predicted to endorse 40% (95% CI [37%, 42%]) of the false items. The model-predicted hit rate was relatively constant—84% (95% CI [82%, 85%])—irrespective of people's levels of attachment anxiety. This pattern of findings suggests that attachment anxiety is related to false memories because people high in attachment anxiety are both positively biased and less sensitive, as compared with people lower in attachment anxiety (see Figure 2). (See Figure 4 for person-level [i.e., vs. item-level logistic] scatterplots of these same associations.)

Next, we used separate models to examine the associations between avoidance and memory ability. In contrast to the attachment anxiety findings, there was no interaction between avoidance and item-veracity ($OR_{true \times avoidance}$ = 0.96, 95% CI [0.89, 1.04]), and avoidance was related to neither false alarms (simple $OR_{avoidance}$ = 1.01, 95% CI [0.93, 1.10]) nor hit rates (simple $OR_{avoidance}$ = 0.97, 95% CI [0.90, 1.06]).

Collectively, the findings from Study 1 suggest that attachment *anxiety* in particular predicts false memories during recognition tasks (McWilliams et al., 2014; Wilson, 2006), and attachment avoidance does not (cf. Ein-Dor et al., 2011).

Study 2

The results of Study 1 suggest that attachment anxiety—but not avoidance—is related to people's propensities to experience false memories for relationally relevant information during recognition tasks. Given that the empirical literature examining the links between attachment and false memories is both small and mixed in its findings (Ein-Dor et al., 2011; McWilliams et al., 2014; Wilson, 2006), Study 2 was designed to replicate Study 1's findings. Moreover, in Study 2, we used a different—and perhaps more ecologically valid—paradigm. In Study 1, participants (a) knew they were completing a memory test before studying the stimuli, and (b) the stimuli were low in mundane realism (i.e., most people do not memorize random word lists in everyday life). Thus, it is possible that the results of Study 1 may not generalize to settings in which participants do not expect a memory test and actively try to remember the words, or to less-artificial stimuli.

To overcome these limitations, in Study 2 participants were not informed that the study pertained to memory—and consequently, the memory test was a surprise. Moreover, the memory stimulus was a real, publicly posted video blog of a woman describing the true story of her recent breakup. We selected this method because we believed that the experience of viewing a video and attempting to remember its content was a close approximation to the real-life experience of listening to other people's stories.

Method

Participants. Participants were recruited through the psychology subject pool and received course credit. Participants were prescreened to have normal or corrected-to-normal hearing and fluency in English, to ensure that they could adequately hear and understand the video. A total of 264 participants completed Study 2. This sample size enabled approximately 93% power to detect associations of the average size found in social/personality psychology (equivalent to $r \sim .21$; Richard et al., 2003). The sample was approximately half (45%) male, and ages ranged from 18 to 25 (M = 19.13, SD = 1.28). The racial composition of the sample was 44% Asian, 41% White, 9% Black, and 8% Hispanic. Sixty-seven percent of the sample indicated that they were not currently

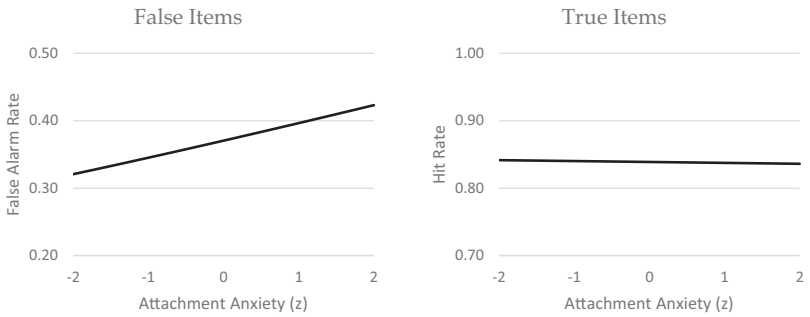

Figure 3. Study 1 model-predicted probabilities of endorsing true and false items on a memory test as a function of standardized attachment anxiety.

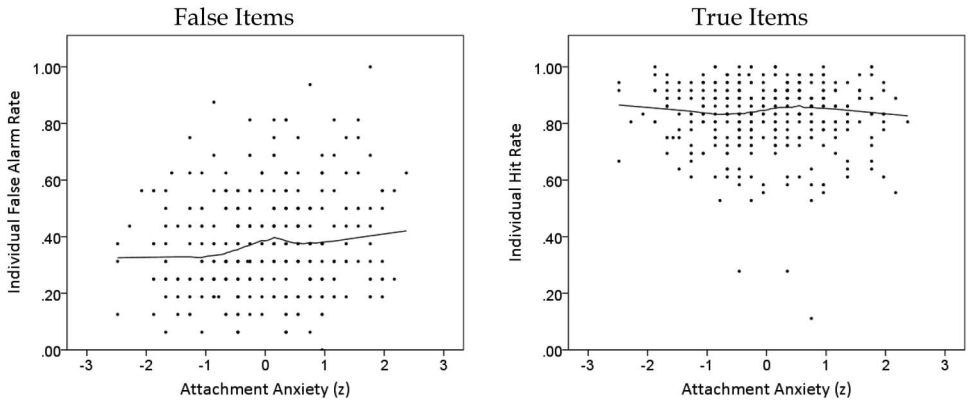

Figure 4. Scatterplots of individuals' mean hit rates and false alarm rates from Study 1 as a function of standardized attachment anxiety. Loess lines fitting 50% of the data are depicted. These graphs were created by computing mean hit rates and false alarm rates for each individual person in the study. These individual mean hit and false alarm rates were plotted against individuals' standardized attachment anxiety. Thus, unlike the models presented in the main text and regression lines depicted in Figure 3—in which *memory items* were the unit of analysis—in this Figure, *persons* were the unit of analysis.

involved in a romantic relationship; the remaining 33% indicated that their romantic relationship was a "committed, nonmarriage relationship" (as opposed to a "casual, nonexclusive" relationship).

Measures.

Attachment orientations. Participants' attachment styles were assessed via the 9-item partner-specific subscale from the Experiences in Close Relationships—Relationship-Structures questionnaire (ECR-RS; Fraley, Heffernan, Vicary, & Brumbaugh, 2011). Previous research suggests that general romantic (e.g., the ECR-S used in Study 1) and partner-specific (ECR-RS) attachment orientations are highly correlated for young, college-aged adults (Hudson, Fraley, Chopik, & Heffernan, 2015). Therefore, to decrease the length of the study, we used the shortest available option: the 9-item ECR-RS partner-specific scale.

The ECR-RS partner-specific subscale measures participants' attachment styles specifically with respect to their current (or, if single, most recent) romantic partner. The ECR-RS contains subscales for attachment anxiety (3 items; e.g., "I often worry that my romantic partner doesn't really care for me") and attachment avoidance (6 items; e.g., "I prefer not to show my romantic partner how I feel deep down"). All items were rated using a Likert scale running from *strongly disagree* (1) to *strongly agree* (5). Items were averaged to form composites for partner-specific attachment anxiety ($\alpha = .87$) and avoidance ($\alpha = .88$).

Procedure. Participants were presented with the cover story that the study was designed to examine whether people can accurately rate someone else's personality just by watching them tell a story. Participants first completed the attachment measure. Subsequently, they watched an approximately 20-minute video in which a woman, Victoria, described a true story of a very tumultuous relationship and resultant breakup with a man pseudonymed "James."[13] The specific video used was chosen because it was engaging and contained detailed descriptions of several episodes in Victoria and James's relationship from which memory test questions could be generated. Furthermore, the video was deeply permeated with themes relevant to attachment anxiety (e.g., difficulty letting ex-partners go), avoidance (e.g., James behaving in ways to minimize closeness and maximize distance), and security (e.g., after breaking up with James, Victoria enters a new relationship with a responsive, caring man).

Immediately afterward, all participants completed a surprise 50-item memory test. Participants were presented with 28 true events that Victoria had described in the video (e.g., "According to Victoria, James told her that she should kill herself"), and 22 false events that Victoria never mentioned in the video (e.g., "According to Victoria, James told her that he never really loved her"). True and false items were written to be roughly balanced in terms of difficulty and specificity. Participants were instructed to rely solely upon what Victoria had actually said in the video, and to not attempt to infer whether the items may or may not have been true. Participants used a binary scale to rate whether each event *occurred* (1) or *did not occur* (0). All analyses examined participants' *false alarm rates* (i.e., endorsement that false items had occurred) and *hit rates* (i.e., endorsement that true items had occurred) during the quiz.

Results and Discussion

We first examined the links between attachment anxiety and memory ability, using the same statistical model as Study 1. Specifically, we modeled the log-odds of endorsing individual items on the memory test as a function of (a) item veracity, (b) attachment anxiety, (c) the interaction between item veracity and attachment anxiety, and (d) a random intercept to model within-person dependencies in the data. The parameter estimates from this MLLM are presented in Table 2. Replicating Study 1, there was an interaction between item veracity and attachment anxiety ($OR_{true \times anxiety} = 0.89$, 95% CI [0.81, 0.97]), such that higher

[13] Victoria never mentions the man's name in the video. However, in all instructions and questionnaires provided to participants, the man was referred to as "James." This was done to disambiguate James from a "new boyfriend" that Victoria mentions at the end of the video, as well as to enable questions and prompts to easily reference James.

Table 2
Study 2 MLLM Predicting Odds of Endorsing True and False Items on the Memory Quiz From Standardized Partner-Specific Attachment Anxiety

Predictor	*b*	Odds ratio	95% CI LB	95% CI UB
Intercept	**−1.65**	—	—	—
Item true	**2.87**	**17.57**	16.05	19.20
Anxiety[a]	**.12**	**1.13**	1.04	1.22
Item True × Anxiety	**−.12**	**.89**	.81	.97

Note. MLLM = multilevel logistic model; CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00.
[a] Because the "item true" variable was dummy coded (0 = false, 1 = true), this is the simple effect of anxiety on *false* items.

levels of attachment anxiety predicted more numerous false alarms (simple $OR_{anxiety}$ = 1.13, 95% CI [1.04, 1.22]); however, attachment anxiety was unrelated to hit rates (simple $OR_{anxiety}$ = 1.00, 95% CI [0.94, 1.07]). As depicted in Figure 5, the model-predicted false alarm rate for people low (1 *SD* below the mean) in attachment anxiety was 15% (95% CI [13%, 16%]). In contrast, people high (1 *SD* above the mean) in attachment anxiety were predicted to endorse 18% (95% CI [16%, 19%]) of the false items. The hit rate—77% (95% CI [76%, 78%])—did not vary as a function of participants' attachment anxiety. (See Figure 6 for person-level [i.e., vs. item-level logistic] scatterplots of these same associations.)

In separate models examining avoidance, avoidance was not statistically significantly related to either false alarm rates (simple $OR_{avoidance}$ = 1.01, 95% CI [0.93, 1.09]) or hit rates (simple $OR_{avoidance}$ = 0.94, 95% CI [0.88, 1.01]), and there was no statistically significant interaction between item veracity and avoidance ($OR_{true \times avoidance}$ = 0.93, 95% CI [0.85, 1.02]).

Collectively, the pattern of results was remarkably similar across Studies 1 and 2. As can be seen by comparing Figures 3 and 5, attachment anxiety predicted more numerous false alarms—but not hits—in both studies. This suggests that attachment anxiety is associated with both higher bias and lower sensitivity in people's memories for relational events (see Figure 2). In contrast, in both Studies 1 and 2, avoidance was not statistically significantly related to memory ability—false alarms or hits. Notably, however, although the association was not statistically significant per se, in both Studies 1 and 2, highly avoidant people trended toward remembering fewer true items. Assuming these coefficients represent true effects that our studies were statistically underpowered to detect, they align with previous research suggesting that highly avoidant individuals are less able to remember true information related to relational stimuli (e.g., Edelstein, 2006; Fraley & Brumbaugh, 2007).

Study 3

Collectively, Studies 1 and 2 demonstrated an association between people's levels of attachment *anxiety*—but not avoidance—and their propensities to falsely remember relationally relevant words or events that never actually occurred, at least in the context of a recognition memory task. However, the data from Studies 1 and 2 were strictly correlational in nature and, therefore, cannot be used to draw strong inferences about whether attachment anxiety *causes* false memories—or the processes through which it might do so (e.g., false memories might cause attachment anxiety; some third variable might cause spurious covariation in attachment anxiety and false memories). To overcome this limitation, in Studies 3–5 we experimentally manipulated people's state-level attachment anxiety at various points in the memory process (see Figure 1) and measured the impact of doing so on participants' false alarm rates. We manipulated only attachment *anxiety*—and not avoidance—because Studies 1 and 2 suggested that only attachment anxiety—and not avoidance—was related to false memories.

Studies 3–5 all used a paradigm similar to Study 2: participants viewed Victoria's breakup video and completed a memory test. The key difference is that in Studies 3–5 we manipulated participants' state-level attachment anxiety at various points in the memory process: before reconstruction (Study 3), during maintenance (Study 4), and before encoding (Study 5). Thus, taken together, the results of Studies 3–5 should allow us to isolate specifically *where* in the memory process attachment anxiety might spur the production of false memories.

Working backward through the model depicted in Figure 1,[14] Study 3 was designed to examine whether people's attachment orientations influence retrieval and reconstruction of memories, potentially producing false memories. Study 3 was a three-group randomized experiment. Following the procedures from Study 2, participants watched Victoria's breakup video. During a second session two days later, immediately before completing a surprise recognition memory test, some participants were primed to experience high- or low-state-levels of attachment anxiety. A third group was not explicitly primed.

To the extent that attachment anxiety promotes injection of false memories during reconstruction, we would expect false alarm rates to be higher among individuals primed with high attachment anxiety, as compared with people in the control group. Because the manipulation occurred *after* encoding and maintenance, and immediately before the memory quiz (see Figure 1), such a finding would support the idea that people high in attachment anxiety reconstruct greater numbers of false details from their gist and verbatim traces and/or mistakenly attribute their chronically activated insecurity as being relevant to the memories being retrieved (e.g., source memory confusion; Dell, 1986; Johnson et al., 1993). If, however, the previously observed links between attachment and

[14] We worked "backward" through the model because doing so improves the pacing of conclusions that can be drawn from each Study. Specifically, in Study 3, the prime proceeded *only* retrieval. Thus, the prime could affect *only* retrieval processes. Thus, Study 3 in and of itself provides concrete information about the role of attachment in retrieval processes. In Study 4, the primes proceeded *both* maintenance *and* retrieval. Thus, the primes might potentially affect maintenance *and* retrieval processes. However, the effect of the primes on retrieval was already known (from Study 3); thus, any difference in effects between Study 3 and Study 4 must be because of the primes affecting maintenance processes. Using similar logic, Study 5 isolated the effects of the primes on encoding. Nevertheless, working "forward" through the model would lead to the same ultimate conclusions. However, the result of earlier studies would remain ambiguous until the results of later studies are known—a scenario that working backward through the model prevents.

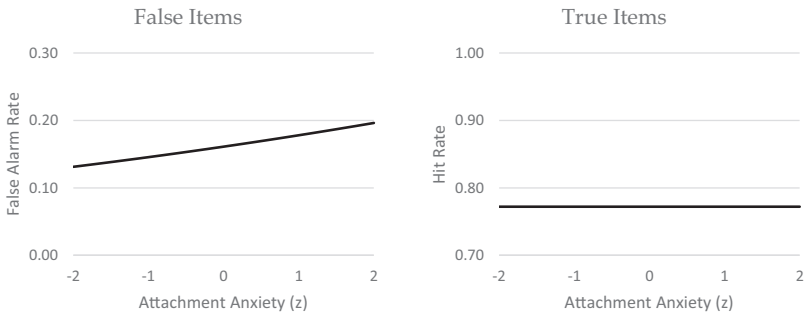

Figure 5. Study 2 model-predicted probabilities of endorsing true and false items on a memory test as a function of standardized attachment anxiety.

false memories (the present Studies 1 and 2; Ein-Dor et al., 2011; McWilliams et al., 2014; Wilson, 2006) are *not* because of errors during reconstruction (but rather errors in other stages of memory), we would expect no differences between the high attachment anxiety group and the control groups in false alarm rates.

It is, in contrast, less clear what to expect with respect to the low attachment anxiety prime. On one hand, lowering levels of attachment anxiety may *reduce* false alarms. On the other hand, most people are relatively low in attachment anxiety (Bartholomew & Horowitz, 1991)—so, the low attachment anxiety prime may have no appreciable effect, as compared with the control group. Finally, it is possible that both the high-anxiety and low-anxiety primes might increase false alarms. Such a phenomenon might indicate that increasing the mental accessibility of any relationship—whether anxiety-provoking or security-fostering—increases false memories.

Method

Participants. Before any data collection, we decided to recruit between 200 and 260 participants per study. Specifically, in Studies 1 and 2, we estimated the association between trait-level attachment anxiety and false memories to be an odds ratio of approximately 1.12. Assuming that our manipulations might exert effects of a similar size, and given the repeated nature of our outcome variable,[15] a sample size of 200–260 participants would enable approximately 70–85% statistical power to obtain odds ratios with 95% CIs that do not include one. The precise sample size within the desired range was determined by the number of participants that could be run in each study before the end of the semester.

Participants were recruited in two ways. First, students could participate through the psychology subject pool to earn course credit. Second, text ads were posted in the psychology building and on the psychology subject pool website. Ad respondents could earn $10 by fully completing both study sessions. Careful records were kept to prevent double participation and exclude individuals who had already participated in Study 2. All participants were required to have normal or corrected-to-normal hearing and fluency in English to ensure that they could adequately hear and understand the memory stimuli.

A total of 265 participants completed the first session of Study 3. Of those, 231 (87%) also completed the second session. Seventy-six percent of the final sample completed the study for course credit, and the remaining participants were paid. Participants' ages ranged from 18 to 56 (M = 19.74, SD = 3.49). The sample was predominantly female (77%), and the racial composition was 56% White, 27% Asian, 10% Black, and 9% Hispanic. Sixty-one percent of the sample indicated that they were not currently involved in a romantic relationship. The remaining participants indicated that they were in a committed (35%) or casual (4%) romantic relationship.

Measures.

Attachment orientations. Attachment styles were assessed in two ways. First, participants completed the 12-item ECR-S (as in Study 1) that measures general-romantic attachment orientations in a way that is consistent with the vast majority of contemporary adult attachment literature. Second, participants completed the 9-item partner-specific subscale from the ECR-RS (as in Study 2).[16] Our primary analyses included the ECR-S (general-romantic) attachment variables as control variables; however, the ECR-RS partner-specific subscales were used to directly replicate the findings from Study 2.

Gist impressions. After watching a video of a woman describing a relationship and breakup, participants rated their gist impressions of the characters in the video, using a combination of existing personality measures and scales constructed for the present studies. This measure was not analyzed in Study 3 per se, but was administered to validate the scale for use in Study 4.

Procedure. Participants scheduled two sessions exactly 2 days apart. Following the procedures from Study 2, in the first session, participants were presented with the cover story that the study was designed to examine whether people can accurately rate someone else's personality just by watching them tell a story—and that we were studying whether and how those ratings change over time. Participants first completed all attachment and demographic measures. Subsequently, participants watched the 20-minute

[15] Two features of the memory quiz—its 52 items and the fact that most of its variance is within persons (ICC = .01)—dramatically increase our effective sample size and statistical power (Kish, 1965).

[16] In this sample, general-romantic and partner-specific working models were highly similar constructs (anxiety r = .74, avoidance r = .78). This may reflect that the sample was largely young individuals who may have had relatively few prior romantic partners (thus, "general" feelings about romantic relationships may be based on as few as one or two previous partners).

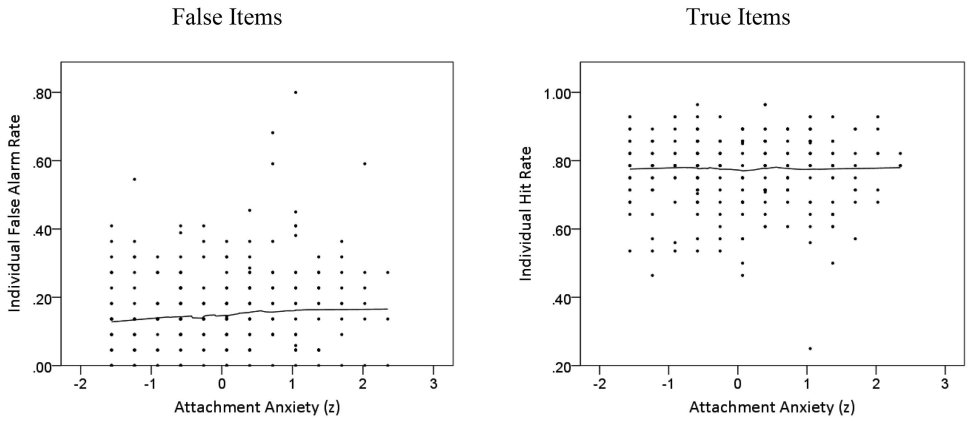

Figure 6. Scatterplots of individuals' mean hit rates and false alarm rates from Study 2 as a function of standardized attachment anxiety. Loess lines fitting 50% of the data are depicted. These graphs were created by computing mean hit rates and false alarm rates for each individual person in the study. These individual mean hit and false alarm rates were plotted against individuals' standardized attachment anxiety. Thus, unlike the models presented in the main text and regression lines depicted in Figure 5—in which *memory items* were the unit of analysis—in this Figure, *persons* were the unit of analysis.

breakup video from Study 2, and rated their gist impressions of Victoria and James.

In a second session 2 days later, participants rerated their gist impressions of Victoria and James. Subsequently, some participants received a prime designed to increase or decrease their state-levels of attachment anxiety (Baldwin, Keelan, Fehr, Enns, & Koh-Rangarajoo, 1996; Carnelley & Rowe, 2007; Gillath et al., 2006; Gillath, Selcuk, & Shaver, 2008). To disguise the purpose of the prime, participants were provided with a cover story that we were interested in how the vividness of their imagination for certain elements of experiences (e.g., sounds, vision, and emotions) relates to their judgments of others' personalities. Following the procedures created by Baldwin and colleagues (1996), participants were randomly assigned to imagine an experience in a close relationship (e.g., with a family member, romantic partner, or best friend) that was characterized by high attachment anxiety or high security (i.e., low attachment anxiety), as defined in the descriptive paragraphs created by Hazan and Shaver (1987).[17,18] This exercise was intended to make salient the kinds of thoughts, feelings, and motives that are relevant to high and low attachment anxiety. For semantic simplicity and consistency with previous research (e.g., Gillath et al., 2008), we refer to the low-attachment-anxiety prime as the "security prime;" however, it is important to note that security, in this context, represents low levels of attachment anxiety,[19] and is not categorically different from attachment anxiety (Fraley, Hudson, Heffernan, & Segal, 2015).

During the priming task, participants were first asked to write about and reflect upon the memory for a minimum of 90 s (although they could take longer, if desired). Subsequently, following the procedures outlined by Baldwin and colleagues (1996), participants were guided (via a 5:30 min audio recording) through a visualization process, visualizing their surroundings in the recalled memory, imagining the sights and sounds from the memory, and critically, remembering how they felt during the recalled instance. Previous research suggests that this type of prime activates thought processes and goals consistent with the primed attachment style (e.g., Baldwin et al., 1996; Carnelley & Rowe, 2007, 2010; Gillath et al., 2006, 2008; Gillath, Sesko, Shaver, & Chun, 2010; Grau & Doll, 2003; Luke, Sedikides, & Carnelley, 2012; McClure, Bartz, & Lydon, 2013; Mikulincer et al., 2001; Mikulincer, Shaver, Gillath, & Nitzberg, 2005; Park, 2007; Selterman & Maier, 2013). To reinforce the cover story, participants were asked about the vividness of their imagination for the sights, sounds, and emotions evoked by the incident.

In addition to the two primed groups, a third group served as an unprimed control group, and did not recall a memory or engage in any visualization exercise. The control group was given a similar cover story: that we were interested in how their visual and auditory perception related to their judgments of others' personalities. The control group listened to a 4:40 min instrumental audio clip (this same instrumental music was played in the background of the visualization primes), viewed an abstract oil painting containing no discernable shapes or themes for 60 s, and wrote about their general perceptions of the audio clip and visual stimuli for a minimum of 60 s. These participants also rated the positivity/

[17] The verbatim text of the high anxiety prime was, "I felt the person was reluctant to get as close as I would have liked. I felt worried that the person didn't really love me, or that they might try to distance themselves from me—perhaps even abandon me. I would've liked to have felt very close with this person, and I worried that my desire to be close might scare them away."

[18] The verbatim text of the security prime was, "I felt the person was relatively easy to feel close to. I felt comfortable depending on them and having them depend on me. I felt confident they really loved me and would not abandon me and would not try to distance themselves from me. I felt comfortable with the level of closeness that we both wanted in the relationship."

[19] Attachment security represents low anxiety *and* low avoidance. However, the "high anxiety" prime described a prototypically *preoccupied* relationship—in which anxiety was high and avoidance was *low* (e.g., the self wants a close relationship but fears rejection). As such, both primes primed low levels of avoidance and only differed in terms of priming high anxiety (i.e., preoccupation) or low anxiety (i.e., security).

negativity of the audio and image. As such, all three groups spent roughly a minimum of 7 min engaging in a combination of tasks that included listening to audio, writing about their experiences, and rating aspects of their experiences.

Immediately after the priming task, all participants completed a surprise 52-item memory test slightly adapted from Study 2.[20] Once again, our primary analyses examined participants' *false alarm rates* (i.e., endorsement that false items had occurred) and *hit rates* (i.e., endorsement that true items had occurred) during the quiz. Importantly, because the priming manipulation occurred *after* people had encoded the video contents into memory and reported their gist impressions and *immediately* before the memory test (see Figure 1), differences in participants' hit rates and false alarm rates across conditions reflect the effects of state-level attachment anxiety on memory processes that occur *during reconstruction and retrieval*. After completing the memory test, all participants were thanked, debriefed, and compensated.

Results and Discussion

Replication of Studies 1 and 2. Before examining the effects of our experimental primes, we first attempted to replicate our findings from Studies 1–2. This was accomplished by using an MLLM to model the odds of endorsing items as a function of (a) item veracity, (b) trait partner-specific attachment anxiety, (c) the interaction between item veracity and trait partner-specific attachment anxiety, and (d) a random intercept to model within-person dependencies in the data.

As can be seen in Table 3, we directly replicated Studies 1 and 2. There was an interaction between trait-level partner-specific attachment anxiety and item veracity ($OR_{true \times anxiety} = 0.92$, 95% CI [0.85, 0.997]), such that as compared with those low in attachment anxiety, people high in attachment anxiety had greater false alarm rates (i.e., endorsement of false items; simple $OR_{anxiety} = 1.10$, 95% CI [1.03, 1.18]), but not hit rates (i.e., endorsement of true items; simple $OR_{anxiety} = 1.01$, 95% CI [0.94, 1.09]). Translated into model-predicted probabilities, individuals low (1 *SD* below the mean) in partner-specific attachment anxiety had predicted false alarm rates of 31% (95% CI [29%, 33%]). The predicted false alarm rate for persons high (1 *SD* above the mean) in partner-specific attachment anxiety was 35% (95% CI [33%, 38%]). These false alarm rates are higher than those found in Study 2 likely because Study 3 included a 2-day delay between watching the video and completing the memory quiz, whereas participants in Study 2 completed the memory quiz immediately after viewing the video.

Table 3
Study 3 MLLM Predicting Odds of Endorsing True and False Items on the Memory Quiz From Standardized Trait Partner-Specific Attachment Anxiety

Predictor	*b*	Odds ratio	95% CI LB	95% CI UB
Intercept	−.70	—	—	—
Item true	**1.80**	**6.05**	5.60	6.55
Trait anxiety[a]	**.09**	**1.10**	1.03	1.18
Item True × Trait Anxiety	**−.08**	**.92**	.85	.997

Note. MLLM = multilevel logistic model; CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00.
[a] Because the "item true" variable was dummy coded (0 = false, 1 = true), this is the simple effect of anxiety on *false* items.

As with the previous studies, avoidance did not predict false alarm rates (simple $OR_{avoidance} = 0.98$, 95% CI [0.91, 1.05]) or hit rates (simple $OR_{avoidance} = 0.96$, 95% CI [0.89, 1.03]), and there was no interaction between avoidance and item veracity ($OR_{true \times avoidance} = 0.98$, 95% CI [0.90, 1.06]). For both attachment anxiety and avoidance, using the ECR-S general-romantic scales instead of the ECR-RS partner-specific scales yielded similar results.

Primary analyses: Did the attachment prime cause false memories? For our next series of analyses, we directly tested the hypothesis that participants primed with high state-levels of attachment anxiety immediately before retrieval would endorse greater numbers of false items, as compared with participants in the unprimed control group. To do so, we used the following MLLM:

$$\begin{aligned}\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = {} & b_0 + b_1(true)_{ij} + b_2(high\ attachment\ anxiety\ prime)_j \\ & + b_3(high\ attachment\ anxiety\ prime)_j\,(true)_{ij} \\ & + b_4(security\ prime)_j + b_5(security\ prime)_j\,(true)_{ij} \\ & + b_6(trait\ attachment\ anxiety)_j + b_7(trait\ avoidance)_j \\ & + U_j\end{aligned}$$

In this model, the experimental primes were dummy-coded with the control group as the reference group (e.g., *high attachment anxiety prime* = [1 if in high attachment anxiety prime condition; 0 otherwise]). As a result, the b_2 parameter captures the effect of the high attachment anxiety prime on *false* items, *as compared to the control group*. The b_3 parameter captures the differential effect of the high attachment anxiety prime on *true* items (vs. false ones), *as compared to the same differential effect in the control group*.

As can be seen in Table 4, neither the attachment anxiety prime nor the security prime had a statistically significant effect on hit rates or false alarm rates when compared with the control group. Similarly, in models directly comparing the effects of the two primes against one another, participants primed with attachment anxiety and attachment security did not differ from one another in false alarms ($OR_{anxiety\text{-}prime\ vs.\ security\text{-}prime} = 1.04$, 95% CI [0.88, 1.23]). Translated into model-predicted probabilities, false alarm rates were 35% (95% CI [32%, 37%]) in the control group, 33% (95% CI [30%, 36%]) in the attachment anxiety prime group, and 32% (95% CI [30%, 35%]) in the security prime group.[21] The predicted hit rates were 75% (95% CI [72%, 77%]) in the control group, 76% (95% CI [73%, 78%]) in the attachment anxiety prime group, and 75% (95% CI [73%, 77%]) in the security prime group. These findings suggest that attachment anxiety may not lead to the production of false memories during memory retrieval or reconstruction processes.

[20] We used the empirical data from Study 2 to better balance the true and false items in terms of difficulty. We also balanced them in terms of number. Thus, there were 26 true items and 26 false ones.

[21] The Appendix contains the raw hit rates and false alarm rates in each group. The model-predicted probabilities were extremely similar to the raw probabilities—and did not differ by more than 1% for any estimate.

Table 4
Study 3 MLLM Analyses Predicting Odds of Endorsing Memory Items as a Function of the Anxiety and Security Primes, Compared With the Unprimed Control Group

Predictor	*b*	Odds ratio	95% CI LB	95% CI UB
Intercept	−.64	—	—	—
Item true	**1.72**	**5.56**	4.85	6.37
High anxiety prime[a]	−.07	.93	.79	1.11
Security prime[a]	−.10	.90	.76	1.06
Item True × High Anxiety Prime	.12	1.13	.93	1.37
Item True × Security Prime	.14	1.14	.94	1.39
Trait anxiety	**.07**	**1.07**	1.01	1.14
Trait avoidance	−.04	.96	.90	1.02

Note. MLLM = multilevel logistic model; CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00.
[a] Because the "item true" variable was dummy coded (0 = false, 1 = true), and the conditions were dummy coded with the "unprimed control group" as the reference group, these coefficients represent simple effects of each prime on *false* items, as compared with the unprimed control group. All continuous predictors were standardized.

Study 4

In Study 3, our findings were consistent with the notion that inducing high levels of attachment anxiety does not inject false memories during retrieval and reconstruction processes. Continuing to work backward through the model depicted in Figure 1, Study 4 was designed to test the hypothesis that attachment orientations might inject false memories during maintenance—perhaps via biasing the content of the gist traces—consequently producing false memories, manifest upon retrieval. Following procedures similar to Study 3, in an initial session, participants reported their trait-level attachment styles and then watched the video of Victoria describing her relationship and breakup with James. The major difference between Study 3 and Study 4 occurred in the second session. In Study 3, participants first rated their gist impressions of Victoria and James and were *subsequently* primed (to ensure that the prime was as temporally proximal to retrieval as possible). In contrast, in the second session of Study 4, participants were primed *before* reporting their gist impressions of Victoria and James. As a result, any direct impacts of the prime would be expected to influence responses on the Time 2 *gist impressions* measure. Furthermore, because participants answered more than 100 questions between the prime and completing the memory test, the prime should not be expected to have a strong *direct* effect on hit rates or false alarm rates. Rather, any effect of the prime on false memories might be expected to be because of the prime biasing people's gist impressions, which subsequently engenders false memories. Consequently, this slight shift in procedure enabled us to examine whether state-levels of attachment anxiety can bias gist traces, and subsequently produce false memories.

To the extent that attachment anxiety biases the maintenance of gist traces, we would expect to find that participants in the high attachment anxiety prime group express more negative gist impressions at Time 2, as compared with the control group. Such a finding would be consistent with the idea that attachment anxiety can bias the maintenance of gist traces over time, producing downstream false memories. In contrast, if attachment anxiety solely biases people's *perceptions* and *encoding* of relationally relevant stimuli (e.g., Miller & Noirot, 1999), we might expect to find no difference between the high-attachment-anxiety prime group and the control group. As in Study 3, it is less clear what to expect regarding how the security prime might function.

Method

Participants. Recruitment procedures for Study 4 were identical to those in Study 3. Careful records were kept to prevent Study 2 and 3 participants from reparticipating in Study 4. A total of 265 participants completed the first session in Study 4. Of those, 245 (92%) also completed the second session. Seventy-six percent of the final sample completed Study 4 for course credit, and the remaining 34% were paid $10 for completing the entire study. The final sample was 70% female, and the racial composition was 59% White, 26% Asian, 8% Black, and 7% Hispanic. Sixty-three percent of the sample indicated that they were single. Thirty-two percent of participants were in a "committed" romantic relationship, and 7% indicated that they were in a "casual" relationship.

Measures.

Attachment. As in Study 3, participants completed the ECR-S general-romantic and ECR-RS partner-specific attachment measures.

Gist impressions. After viewing the video of Victoria describing her relationship and breakup with James, participants rated their gist impressions of both Victoria and James. Specifically, participants rated Victoria's and James's: (a) personality traits, using a combination of the Ten Item Personality Inventory (6 items; Gosling, Rentfrow, & Swann, 2003) and Big Five Inventory (17 items; John & Srivastava, 1999; e.g., "I see Victoria as someone who is anxious, easily upset"); (b) attachment security, using a shortened and modified version of the ECR-RS (6 items; e.g., "I see James as someone who doesn't feel comfortable opening up to romantic partners); (c) supportive behavior, in terms of severing as a secure base and safe haven for romantic partners (3 items; e.g., "I see James as someone who would make his romantic partner feel better when they are upset"; Fraley & Davis, 1997); and (d) morality-related trait-descriptive adjectives generated for this study (18 items; e.g., "I see James as someone who is honest;" "I see Victoria as someone who is loyal"). This amounted to a total of 100 items (50 per character), each of which was rated on a Likert scale from *strongly disagree* (1) to *strongly agree* (5).

Although these items measure a variety of different constructs, they all assess general impressions of Victoria and James. Furthermore, there is a relatively clear positive and negative pole for each of these dimensions—even for personality traits (Dunlop, Telford, & Morrison, 2012; Hudson & Fraley, 2016; Hudson & Roberts, 2014). As a result, the extent to which participants universally rated Victoria and James more positively or negatively across all items provides an assessment of the valence of their gist impressions of the characters. Items were averaged together to form composites for participants' gist impressions of (a) Victoria, (b)

James, and (c) overall gist impressions of both Victoria and James.[22]

Procedure. As in Study 3, participants scheduled two sessions, exactly 2 days apart. The procedures in the first session were identical to those in Study 3. Specifically, participants completed the attachment and demographic measures. They subsequently watched the 20-minute video of Victoria describing her relationship and breakup with James, and rated their gist impressions of Victoria and James.

The major difference in Study 4 occurred in the second session. In the second session, participants were immediately randomly assigned into three groups and received the primes described in Study 3 (attachment anxiety prime, security prime, or unprimed control). They subsequently recompleted the gist-impression measure and were presented with the surprise memory quiz. In contrast to Study 3, which was concerned with how attachment influences *reconstruction and retrieval* of memories, Study 4 focused on whether and how *the gist traces themselves* are biased during maintenance processes by priming attachment anxiety, and whether such biases might predict downstream false memories.

Results and Discussion

Replication of correlation between attachment anxiety and false alarms. We first attempted to replicate the correlation between trait-level attachment anxiety and false memories found in Studies 1–3. For consistency with Studies 2 and 3, we first examined whether trait-level *partner-specific* attachment anxiety predicted false memories. With respect to false items, the OR (simple $OR_{anxiety}$ = 1.05, 95% CI [0.98, 1.11]) was similar to what was found in Studies 2 and 3, but it was not statistically significantly different from 1.00. With respect to endorsement of true items, although the interaction between item veracity and trait-level attachment anxiety was not statistically significant ($OR_{true \times anxiety}$ = 1.03, 95% CI [0.96, 1.12]), trait attachment anxiety *was* statistically significantly related to endorsement of true items (simple $OR_{anxiety}$ = 1.08, 95% CI [1.01, 1.16]). Using general-romantic (ECR-S) attachment anxiety measures instead of the partner-specific measures yielded similar results, with the exception that trait-attachment-anxiety was *not* statistically significantly related to endorsement of true items (simple $OR_{anxiety}$ = 1.04, 95% CI [0.98, 1.12]).

Does attachment anxiety bias people's gist impressions? Our primary analysis for Study 4 examined how participants' gist-impressions at Time 2 varied as a function of the attachment anxiety prime and security prime, controlling for their initial impressions at Time 1. To do so, the following ordinary least-squares regression was used:

$$(Gist_{T2})_j = b_0 + b_1(high\ attachment\ anxiety\ prime)_j + b_2(security\ prime)_j + b_3(trait\ attachment\ anxiety)_j + b_4(trait\ avoidance)_j + b_5(Gist_{T1})_j + \varepsilon_j$$

The gist impression and trait attachment variables were standardized before being entered into the model, whereas the attachment anxiety prime and security prime variables were dummy coded with the unprimed control group as the reference group. As a result, the coefficients for the attachment anxiety and security primes are similar (albeit not necessarily identical) to *d*s—the standardized difference between primed participants and participants *in the unprimed control group*. The coefficients for trait attachment anxiety, trait avoidance, and Time 1 gist impressions are similar (albeit not necessarily identical) to βs—the standardized associations between the predictors and outcome. To remind readers of these interpretational nuances, we use the notation b_d and b_β to refer to *d*-like and β-like effects, respectively.

As can be seen in Table 5, as compared with the unprimed control group, neither prime had an effect on people's gist impressions at Time 2, controlling for their initial Time 1 impressions, all $|b_d|$s ≤ 0.11 (notably, if the model is reconfigured such that the security prime group is the reference group, participants primed with high anxiety also did not statistically significantly differ in overall gist impressions from those primed with security, $b_d = -0.14$, 95% CI [−0.33, 0.04]). This may be partially because of the fact that people's impressions were quite stable over time for Victoria (b_β = 0.84, 95% CI [0.77, 0.91]), James (b_β = 0.83, 95% CI [0.75, 0.90]), and overall (b_β = 0.79, 95% CI [0.72, 0.87]). Taken together, these findings suggest that the prime did *not* influence people's overall gist impressions, nor their individual impressions of Victoria and James. This may suggest that high levels of attachment anxiety do not bias people's gist traces over time. Alternatively, it is possible that attachment styles *do* bias gist impressions over time (e.g., Dykas et al., 2010, 2012; Simpson et al., 2010; Woodhouse & Gelso, 2008), but that longer periods of time and/or repeated priming would be necessary to induce such an effect experimentally.

Did the primes induce false memories? As can be seen in Table 6, neither the high-attachment-anxiety prime nor the security prime had any effect on endorsement of false or true items, as compared with the control group. Similarly, in models directly comparing the effects of the primes to one another, participants primed with attachment anxiety and attachment security did not differ from one another in terms of false alarms ($OR_{anxiety\text{-}prime\ vs.\ security\text{-}prime}$ = 1.02, 95% CI [0.88, 1.20]). Translated into model-predicted probabilities, the false alarm rates were 31% (95% CI [29%, 34%]) in the control group, 33% (95% CI [30%, 35%]) in the attachment anxiety prime group, and 32% (95% CI [30%, 34%]) in the security prime group. Hit rates were 76% (95% CI [73%, 78%]) in the control group, 77% (95% CI [74%, 79%]) in the attachment anxiety prime group, and 75% (95% CI [73%, 77%]) in the security prime group.

This lack of differences between the experimental groups is not particularly surprising for at least two reasons. First, the primes did not affect gist impressions. Moreover, even if it were possible to influence gist impressions over longer periods of time or with repeated priming, follow-up analyses revealed that gist impressions were unrelated to endorsement of false items (simple OR_{gist} = 0.99, 95% CI [0.92, 1.05]). Consequently, Study 4 suggests that, even if attachment does produce biases in memory over time (i.e., if the correlations found in previous research are because of causal processes; Dykas et al., 2010, 2012; Simpson et al., 2010; Woodhouse &

[22] Notably, our operationalization of *gist impressions* may differ from techniques used in the cognitive literatures to disambiguate verbatim and gist traces. Ultimately, our goal was not to soundly determine the extent to which memories in Study 4 represented gist versus verbatim traces. Rather, our goal was to test an idea conceptually similar Brainerd and Reyna's (2002) claims that people sometimes create false memories that are consistent with the gist, but not verbatim details, of their experiences.

Table 5
Study 4 Effects of the Attachment Primes on Gist Impressions of Victoria and James

	Time 2 gist impressions of:								
	Victoria			James			Overall		
		95% CI			95% CI			95% CI	
Predictor	*b*	LB	UB	*b*	LB	UB	*b*	LB	UB
Intercept	−.03	−.14	.09	−.02	−.14	.10	−.04	−.17	.09
High anxiety prime[a]	−.01	−.18	.16	−.01	−.18	.16	−.02	−.21	.17
Security prime[a]	.08	−.08	.25	.05	−.12	.22	.11	−.07	.29
Trait anxiety	.00	−.07	.07	−.05	−.12	.02	−.04	−.12	.04
Trait avoidance	**−.07**	−.14	−.00	.05	−.02	.12	−.02	−.11	.05
Relevant gist, Time 1	**.84**	.77	.91	**.83**	.75	.90	**.79**	.72	.87

Note. CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00. All variables, including the outcome, are standardized *except* the prime groups, which are dummy coded. As such, the coefficients for prime groups are similar to *d*s, and all other coefficients are similar to βs.
[a] Because the conditions were dummy coded with the "unprimed control group" as the reference groups, these represent the effects of the primes, relative to the unprimed control group. All continuous predictors were standardized.

Gelso, 2008), these types of emotional biases per se may not catalyze *false memories*.

Taken together, Studies 3 and 4 suggest that attachment anxiety does *not* inject false memories during maintenance or retrieval processes. Moreover, Study 4 may suggest that state-level attachment anxiety does not affect the positivity or negativity of people's gist impressions. Of course, it may be the case that longer periods of time or repeated priming would be necessary to influence gist impressions over time.

Study 5

The findings from Studies 3 and 4 are consistent with the idea that attachment anxiety does not lead to the production of false memories during maintenance or retrieval processes. Thus, continuing to work backward through the model depicted in Figure 1, Study 5 was designed to test whether attachment anxiety injects false memories during memory creation and encoding processes. The major difference between Study 5 and Studies 3 and 4 is that participants were assigned to be primed with high attachment anxiety, security (i.e., low attachment anxiety), or to receive no prime immediately *before* watching the video of Victoria describing her relationship with James. Because Studies 3 and 4 suggested that state-level attachment anxiety does not elicit false memories during reconstruction and maintenance processes, any effect of the prime on false memories in Study 5 seemingly must be attributable to attachment anxiety facilitating the creation of false memories *during encoding processes* (see Figure 1).

To the extent that attachment anxiety engenders false memories during encoding processes, participants in the attachment anxiety prime condition should exhibit greater false alarm rates than participants in the unprimed control group. If, however, the previously observed correlational links between attachment anxiety and false memories (the present Studies 1–3; McWilliams et al., 2014; Wilson, 2006) are not *causal* (but rather because of other processes, including reverse causality or unspecified third variables), we should expect to observe no difference between the prime groups in false alarm rates. As in Studies 3 and 4, given that most people are already relatively secure, it is not clear what to expect in terms of what effect the security prime might have.

Table 6
Study 4 MLLM Analyses Predicting Odds of Endorsing Memory Items as a Function of the Anxiety and Security Primes, Compared With the Unprimed Control Group

			95% CI	
Predictor	*b*	Odds ratio	LB	UB
Intercept	−.78	—	—	—
Item True	**1.92**	**6.80**	5.96	7.76
High anxiety prime[a]	.06	1.06	.91	1.24
Security prime[a]	.04	1.04	.89	1.20
Item True × High Anxiety Prime	−.01	.99	.82	1.20
Item True × Security Prime	−.06	.95	.79	1.14
Trait anxiety	.03	1.03	.98	1.09
Trait avoidance	.05	1.05	1.00	1.11

Note. MLLM = multilevel logistic model; CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00.
[a] Because the "item true" variable was dummy coded (0 = false, 1 = true), and the conditions were dummy coded with the "unprimed control group" as the reference group, these coefficients represent simple effects of each prime on *false* items, as compared with the unprimed control group. All continuous predictors were standardized.

Method

Participants. Participant recruitment procedures were identical to those in Studies 3 and 4. Careful records were kept to prevent Study 2–4 participants from reparticipating in Study 5. All participants were prescreened for normal or corrected-to-normal hearing and fluency in English to ensure that they could adequately hear and understand the memory stimuli. A total of 251 participants completed Study 5. Seventy-six percent of the sample completed the study for course credit; the remaining participants were paid $7 for fully completing the study. The sample was 64% female, and ages ranged from 18 to 56 years old (M = 19.90, SD =

2.71). The sample was 61% White, 29% Asian, 11% Hispanic, and 2% Black. Sixty-one percent of the sample indicated that they were currently single. The remaining participants indicated that they were in a causal (7%) or committed (34%) romantic relationship.

Measures. All measures were identical to those in Studies 3 and 4.

Procedure. Study 5 was a shortened, single-session version of Studies 3 and 4. Immediately upon arriving in the lab, participants completed the attachment measures. They were then randomly assigned into one of three groups and primed with high attachment anxiety, security (i.e., low attachment anxiety), or were not primed, using identical procedures to those in Studies 3 and 4. Immediately after the prime, participants viewed the video of Victoria describing her breakup with James. Subsequently, participants completed the gist impression measure and surprise memory quiz.

There were two major methodological differences between Study 5 and the previous two studies. First and most critically, the attachment prime in Study 5 came immediately before encoding the contents of the video into memory. Combined with the fact that Studies 3 and 4 suggested that attachment anxiety does not cause false memories during maintenance or retrieval, any direct effect of the prime on false alarm rates seemingly must be because of attachment anxiety affecting encoding processes. The second divergence from previous methods was that Study 5 was a single session.[23] As such, participants did not experience a 2-day delay between watching the video and completing the memory quiz. Although this is a difference in procedure from Studies 3 and 4, it is consistent in methodology with Studies 1 and 2.

Results and Discussion

Replication of correlation between attachment anxiety and false alarms. Before examining the effects of our experimental primes, we attempted to replicate the correlational link between trait-level attachment anxiety and false memories. There was an interaction between trait-level partner-specific attachment anxiety and item veracity ($OR_{true \times anxiety}$ = 0.89, 95% CI [0.82, 0.97]), such that partner-specific attachment anxiety was related to false alarm rates (simple $OR_{anxiety}$ = 1.08, 95% CI [1.002, 1.17]) but not hit rates (simple $OR_{anxiety}$ = 0.96, 95% CI [0.89, 1.04]). Translated into model-predicted probabilities, people 1 *SD* below the mean in partner-specific attachment anxiety were predicted to endorse 22% (95% CI [21%, 24%]) of the false items; whereas people 1 *SD* above the mean in partner-specific attachment anxiety were predicted to endorse 25% (95% CI [23%, 27%]) of the false items. Trait-level general-romantic (ECR-S) attachment anxiety also interacted with item veracity ($OR_{true \times anxiety}$ = 0.82, 95% CI [0.75, 0.90]), such that trait-level general-romantic attachment anxiety was related to more numerous false alarms (simple $OR_{anxiety}$ = 1.18, 95% CI [1.08, 1.29]), but was unrelated to hit rates (simple $OR_{anxiety}$ = 0.97, 95% CI [0.88, 1.06]).

Did the attachment prime cause false memories? Next, we tested whether priming attachment anxiety before encoding resulted in more numerous false alarms during the memory quiz. As can be seen in Table 7, there was an interaction between the high attachment anxiety prime and item veracity ($OR_{true \times anxiety\text{-}prime}$ = 0.72, 95% CI [0.59, 0.88]), such that, as compared with participants in the unprimed control group, participants in the high attachment anxiety prime group experienced greater numbers of false alarms (simple $OR_{anxiety\text{-}prime}$ = 1.23, 95% CI [1.02, 1.49]), but the prime was not statistically significantly related to hit rates (simple $OR_{anxiety\text{-}prime}$ = 0.89, 95% CI [0.73, 1.08]).

Table 7
Study 5 MLLM Analyses Predicting Odds of Endorsing Memory Items as a Function of the Anxiety and Security Primes, Compared With the Unprimed Control Group

Predictor	*b*	Odds ratio	95% CI LB	95% CI UB
Intercept	−1.28	—	—	—
Item true	**2.68**	**14.60**	12.62	16.89
High anxiety prime[†]	**.21**	**1.23**	1.02	1.49
Security prime[†]	.13	1.14	.94	1.37
Item True × High Anxiety Prime	**−.33**	**.72**	.59	.88
Item True × Security Prime	**−.24**	**.78**	.64	.96
Trait anxiety	.06	1.06	.99	1.13
Trait avoidance	.03	1.03	.96	1.10

Note. MLLM = multilevel logistic model; CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00.
[†] Because the "item true" variable was dummy coded (0 = false, 1 = true), and the conditions were dummy coded with the "unprimed control group" as the reference group, these coefficients represent simple effects of each prime on *false* items, as compared with the unprimed control group. All continuous predictors were standardized.

This interaction is illustrated in Figure 7. The model-implied false alarm rate in the unprimed control group was 22% (95% CI [20%, 24%]), whereas the false alarm rate in the high-attachment-anxiety prime group was 26% (95% CI [23%, 28%])—an absolute increase of approximately 4%. This finding is consistent with the idea that attachment anxiety does, in fact, facilitate the production of false memories—and it does so at the time that memories are created and encoded. Moreover, the fact that high state-levels of attachment anxiety inflated false alarm rates but did not affect hit rates is most consistent with the notion that attachment anxiety promotes false memories by simultaneously biasing and desensitizing people's memories (see Figure 2).

In contrast to the attachment anxiety prime, although there was an interaction between the security prime and item veracity ($OR_{true \times security\text{-}prime}$ = 0.78, 95% CI [0.64, 0.96]), the security prime did not educe a statistically significant change in false alarm rates (simple $OR_{security\text{-}prime}$ = 1.14, 95% CI [0.94, 1.37]) or hit rates (simple $OR_{security\text{-}prime}$ = 0.89, 95% CI [0.73, 1.08]). In terms of model-predicted probabilities, among participants primed with security, the false alarm rate was 24% (95% CI [22%, 26%]). Hit rates were 80% (95% CI [78%, 82%]) in the control group, 78% (95% CI [76%, 80%]) in the attachment anxiety prime group, and 78% (95% CI [76%, 81%]) in the security prime group.

[23] This was done for two reasons. First, because the prime was expected to exert its influence on encoding and the previous studies showed that attachment does not produce false memories during maintenance or reconstruction, a 2-day delay was not necessary to isolate maintenance or reconstruction processes. Second, because of funding and subject pool constraints, a single-session study enabled double the number of participants to be collected.

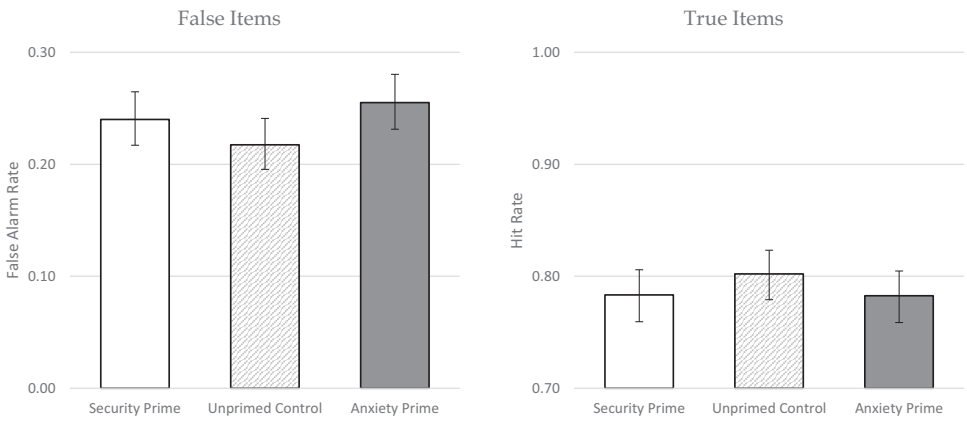

Figure 7. Study 5 effect of priming attachment before encoding on endorsement of true and false items in the memory quiz, with 95% confidence intervals depicted.

Comparison of the attachment anxiety and security primes. Our primary analyses contrasted each of the prime groups individually with the unprimed control group. These analyses revealed that, as compared with the unprimed control group, the high attachment anxiety prime significantly increased false alarms (OR = 1.23), whereas the security prime did not (OR = 1.14). However, the effect of both primes was in the same direction. In other words, from a purely descriptive standpoint and irrespective of statistical significance, both the attachment anxiety and security primes increased false alarms, as compared with the unprimed control group.

Consequently, in analyses that compared participants primed with high attachment anxiety to both other conditions collapsed together (i.e., unprimed controls and those primed with security), the high anxiety prime still increased false alarms, albeit the effect fell just short of statistical significance ($OR_{anxiety\text{-}prime\ vs.\ combined\ control\ group} = 1.20$, 95% CI [0.996, 1.45], $p = .055$). And moreover, in analyses that directly compared the attachment anxiety and security primes to each other, the two primes did not have a statistically significantly different effect on false alarms ($OR_{anxiety\text{-}prime\ vs.\ security\text{-}prime} = 1.10$, 95% CI [0.89, 1.37]; the false alarm rate in the attachment anxiety condition was 26%, 95% CI [23%, 28%] and the false alarm rate in the security prime condition was 24%, 95% CI [22%, 26%]).

Collectively, these findings create a critical statistical ambiguity in our pattern of results. Namely, the effect of the security prime was different from neither the control group nor the anxiety prime group. Thus, based solely on statistical significance, we cannot conclude that the security prime had an effect in increasing false alarms—but we also cannot conclude that the security prime had a different effect from the anxiety prime. The fact that the security prime may have behaved similarly to the anxiety prime was not expected and complicates the interpretation of our findings in Study 5. Namely, our pattern of results can be interpreted in at least three different ways. The first interpretation is that the attachment anxiety prime increased false alarms—and the security prime only appeared to do so (albeit not statistically significantly) because of sampling error.

A second interpretation of this pattern is that, if the security prime's effects represent a real phenomenon (and are not attributable to sampling error), there may be a confound in Study 5. Namely, it may be the case that reflecting on *any* type of relational memory—whether anxiety-provoking or security-fostering—spurs false memories. Thus, Study 5 may not indicate that high state levels of attachment anxiety at the point of encoding produce false memories. Rather, Study 5 may instead suggest that *thinking about one's relationships—for better or for worse*—at the point of encoding has the potential to spur more numerous false memories (at least for other relationally relevant information).

A third interpretation of our findings in Study 5 is that both primes may have unintentionally manipulated the *mechanisms* that link attachment anxiety to false memories. Specifically, as we described above, one reason attachment anxiety might cause false memories is that people who are highly anxious with respect to attachment are preoccupied with their relationships, and their chronically activated relational schemata might get encoded alongside the actual events that occur, later producing false memories that are consistent with the gist of those schemata. In addition to manipulating participants' state levels of attachment anxiety, both primes may have also increased the cognitive accessibility of relational themes in participants' minds. In other words, both primes may have encouraged participants to reflect upon their relationships—as highly anxious individuals chronically do—before encoding the contents of Victoria's video. The resultantly activated relational schemata may have biased the encoding of the events that occurred in the video. Thus, both primes may have manipulated a *mechanism* linking attachment anxiety to false memories (accessibility of relational schemata during encoding)—and the attachment anxiety prime may have had a stronger effect because it *also* manipulated state-level attachment anxiety, in addition to the accessibility of relational schemata. Although this interpretation is consistent with our theoretical reasoning—it is ultimately post hoc and should be considered cautiously.

Importantly, these explanations are not necessarily mutually exclusive. For example, from a purely descriptive standpoint, the effect of the anxiety prime was approximately double the effect of the security prime, as compared with the control group (an increase of 4 and 2%, respectively). It may, therefore, be possible that both primes served to increase false memories before some common "ingredient" (e.g., reflection on close relationships)—but the anx-

iety prime increased false alarms to a greater degree because it also activated high levels of state attachment anxiety.

Thus, to summarize, there are alternative ways to interpret the results of Study 5. We are inclined to conclude that high state-levels of attachment anxiety can, in fact, facilitate the production of false memories. It appears to do so by both biasing and desensitizing people's memories during encoding process (see Figure 2). These conclusions must be tempered, however, by the fact that the security prime also had a tendency, albeit not significantly, to increase false memories. Thus, there are other potential interpretations of these data that should be borne in mind.

General Discussion

One of the important questions in research on adult attachment and cognition concerns the ways in which individual differences shape how people encode and remember their interpersonal experiences (e.g., Edelstein, 2006; Fraley, Garner, et al., 2000; Miller, 2001). In the present research, we specifically focused on how individual differences in attachment might lead to false memories—memories for events that, in fact, did not take place (Ein-Dor et al., 2011; McWilliams et al., 2014; Wilson, 2006). As can be seen in Table 8, which summarizes our core findings across all five studies, we consistently found that attachment anxiety—but not avoidance—predicted people's propensities to experience false relationally relevant memories on a recognition task (McWilliams et al., 2014; Wilson, 2006).[24] In our three latter studies, we examined whether this correlation reflects a causal process by temporarily manipulating participants' attachment anxiety before retrieval (Study 3), maintenance (Study 4), or encoding (Study 5; see Figure 1). In Studies 3 and 4, inducing attachment anxiety immediately before retrieval or during maintenance processes had no impact on false memories. In contrast, in Study 5, priming attachment anxiety before encoding caused participants to experience more numerous false memories than their unprimed peers (but not those primed with attachment security) during a subsequent recognition memory quiz. Collectively, our studies are tentatively consistent with the idea that people who are anxiously attached tend to experience false memories because attachment anxiety facilitates the creation of false memories during encoding processes. However, as we discuss in greater depth below, the fact that participants primed with anxiety and security did not statistically significantly differ in terms of false alarms may indicate that a confound—such as reflection upon close relationships—may partially explain our pattern of results, rather than attachment anxiety in isolation. We review these findings in depth and discuss their implications in the sections that follow.

How Do Individual Differences in Attachment Influence the Construction of False Memories?

Our findings consistently demonstrated that people who are anxious with respect to attachment concerns are more likely than those who are not to remember certain relational events as taking place that, in fact, did not take place—at least on recognition memory tests. The purpose of our latter three studies was to identify how and where attachment anxiety might influence the construction of false memories. The process leading from experiencing an event to remembering details of that event is a complex one, and it can potentially "break down" at a variety of junctures. For example, attachment-related processes can potentially interfere with the way in which events are encoded, potentially leading people to encode information that, in fact, was not present. Once false information is represented in memory, it might be difficult to challenge, especially if it feels real and vivid (Brainerd & Reyna, 2002; Straube, 2012). Breakdowns can also occur during rehearsal and maintenance. If people are reminiscing about an experience, for example, their attachment-relevant biases might lead them to falsely recall events that did not take place, such that those false details become part of the memory itself. Finally, attachment processes may bias memory at the level of retrieval. The act of recollecting an experience often involves reactivating directly and indirectly the associates of that experience. Attachment-related biases, therefore, have the potential to shape that process, potentially leading people to recall something that is expectation-consistent, but in fact, not veridical with the experience itself.

One of the innovations of this program of work is that we attempted to isolate where in this process attachment-related biases may shape the production of false memories. Specifically, we systematically induced attachment anxiety in people using methods that allowed us isolate the effects of attachment anxiety on (a) encoding, (b) maintenance, or (c) retrieval. Our results suggest that attachment anxiety may influence the production of false memories at the level of encoding—but not maintenance or retrieval. That is, people who were primed with attachment anxiety *before* viewing a video of a woman describing a recent breakup were more likely than were unprimed control participants to falsely remember details from the story that did not exist. Moreover, primed participants did not experience more numerous *hits* (i.e., correctly recognizing true events). These findings support the idea that increasing attachment anxiety can lead to the production of memories for events that did not happen—and that these errors of commission occur when memories are first created.

That said, one critical ambiguity in the present research was that the security prime behaved in an unexpected fashion. Namely, participants primed with attachment security before watching the video *also* experienced more numerous false alarms than their unprimed peers—although the effect was not statistically significant. As a consequence, participants primed with attachment anxiety did not experience statistically significantly more numerous false memories than those primed with security (i.e., the security prime condition was not statistically different from the unprimed control group or the attachment anxiety prime condition).

Although the unexpected behavior of the security prime may be attributable to sampling error—it may also indicate the presence of an underlying confound. Specifically, both primes asked participants to reflect on prior relational experiences—with the critical difference being whether those experiences were security-fostering or anxiety-provoking. To the extent that both primes actually spurred false memories (i.e., the effect of the security prime is not merely attributable to sampling error), this may indicate that re-

[24] The one exception was Study 4—in which the correlation between anxiety and false alarms was not significantly different from the null. However, the association in Study 4 was also not significantly different from the associations found in all four other studies.

Table 8
Simple Effects of Trait Attachment Anxiety and Attachment Anxiety Prime on False Alarms Across All Studies

	Variable predicting false alarms								
	Trait anxiety			Anxiety prime versus unprimed control			Anxiety prime versus security prime		
		95% CI			95% CI			95% CI	
Study	OR	LB	UB	OR	LB	UB	OR	LB	UB
Study 1	**1.12**	1.02	1.21	—	—	—	—	—	—
Study 2	**1.13**	1.04	1.22	—	—	—	—	—	—
Study 3–Retrieval	**1.10**	1.03	1.18	.93	.79	1.11	1.04	.88	1.23
Study 4–Maintenance	1.05	.98	1.11	1.06	.91	1.24	1.02	.88	1.20
Study 5–Encoding	**1.08**	1.002	1.17	**1.23**	1.02	1.49	1.10	.89	1.37

Note. OR = odds ratio; CI = confidence interval; LB = lower bound; UB = upper bound; anxiety = attachment anxiety; 95% CIs for parameters in boldface do not include 1.00.

flecting on *any* relational memory, whether positive or negative, has the potential to spur false memories.

Although we did not anticipate this phenomenon a priori, it may indicate that both primes unintentionally manipulated the *mechanisms* we believe link attachment anxiety to false memories. Namely, as we elaborate below, highly attachment-anxious individuals are preoccupied with their relationships and, thus, relational schemata are chronically activated and easily accessible for them (Hazan & Shaver, 1987; Mikulincer & Shaver, 2016). To the extent that these schemata are highly activated and accessible at the time of memories are created, their general gist may be encoded alongside the actual events that occurred, producing subsequent false memories. Thus, both primes—that asked people to reflect upon their relationships—may have increased the accessibility of relational schemata and thereby manipulated the mechanism that links attachment anxiety to false memories. Although this explanation dovetails nicely with our rationale for why attachment anxiety should predict false memories, it is ultimately speculative and should be approached with caution until more fully tested by future research.

Irrespective of these issues, from a signal-detection theory perspective (e.g., Dobbins, Khoe, Yonelinas, & Kroll, 2000), the fact that attachment anxiety was related to *false alarm rates* but unrelated to *hit rates* suggests that attachment anxiety promotes false memories by both *desensitizing* and *biasing* people's memories. Although bias and sensitivity do not have one-to-one correspondence with specific cognitive processes, they can be used to help elucidate potential mechanisms underlying false memories. With respect to desensitization, it is possible that high attachment anxiety leads people to focus their attention toward cues suggestive of rejection, acceptance, or other relationally important emotions (e.g., Chris Fraley et al., 2006) at the expense of attending to other information. As a consequence, highly anxious people may simply have less reliable and accurate memory traces, essentially forcing them to guess more about what happened when reconstructing memories (Dobbins et al., 2000). More important, this does not imply that people with insensitive memories must consciously guess when remembering prior events; indeed, their memories of what occurred may seem quite subjectively compelling to them (Brainerd & Reyna, 2002). Nevertheless, because memories are reconstructed from less reliable, poorer-quality information, the consequence of memory insensitivity is lowered hit rates and inflated false alarm rates (see Figure 2).

With respect to bias, it is possible that the chronically activated relational themes in highly anxious people's minds (Fraley & Shaver, 2000; Hazan & Shaver, 1987; Mikulincer & Shaver, 2016) are fallaciously encoded into gist traces linked to the memory in question. As a result, highly anxious individuals may be *biased* toward remembering—likely in a subjectively compelling fashion (Brainerd & Reyna, 2002; Straube, 2012)—that essentially any relationally relevant detail had, in fact, occurred. The result of this type of bias is inflation of both hit rates and false alarm rates. Notably, as can be seen in Figure 2, because bias and insensitivity have opposite effects on hit rates, they can mutually cancel—creating the appearance that attachment anxiety promotes false alarms but is unrelated to hit rates (see Figures 3–6).

Perhaps coincidentally, the idea that attachment anxiety causes *errors of commission* during encoding dovetails nicely with previous research showing that attachment *avoidance* appears to exert an influence on *errors of omission* (i.e., not remembering) because of processes that occur during memory formation and encoding (Edelstein, 2006; Fraley & Brumbaugh, 2007; Miller & Noirot, 1999). To this end, theorists have argued that hyperactivating (e.g., intensely seeking attachment bonds) and deactivating (e.g., minimizing the importance of attachment bonds) strategies, respectively, associated with attachment anxiety and avoidance frequently have opposite effects as compared with each other (Mikulincer & Shaver, 2016). Consequently, it may be the case that the processes that link attachment anxiety to false memories represent "the opposite pole" of the same processes that link attachment avoidance to errors of omission. Alternatively, it is entirely possible that different process link attachment anxiety to errors of commission than those that link avoidance to errors of omission—and the fact that both are thought to occur during encoding is entirely coincidental.

Ultimately, however, the precise processes linking attachment anxiety to errors of commission and avoidance to errors of omission are not well understood. Therefore, future studies should identify and investigate potential mechanisms—including attentional biases (e.g., Edelstein, 2006; Chris Fraley et al., 2006), spreading activation during encoding (Straube, 2012), or other

factors—that might link each attachment dimension to different types of memory errors.

Implications, Limitations, and Future Directions

What Are the Downstream Consequences of False Memories?

Collectively, the findings from our studies are consistent with the idea that attachment anxiety leads to errors of commission at the time that memories are initially created and encoded. Moreover, attachment anxiety may promote false memories by simultaneously desensitizing and biasing the way people process information (Dobbins et al., 2000; Macmillan & Creelman, 1991). These findings may have important implications for understanding adult attachment dynamics more generally. As one example, high levels of attachment anxiety may be self-reinforcing, in part, because of an inability to accurately reconstruct past events. To the extent that individuals confabulate interpersonal experiences in ways that are biased toward their existing insecurities, their insecure working models of relationships would be reinforced and it would be difficult for newer interpersonal experiences to challenge or invalidate their insecurities.

Following this line of reasoning, future research should explore the downstream consequences of attachment-driven false memories. For example, intensive longitudinal designs could estimate the extent to which attachment anxiety predicts subsequent false memories, as well as the degree to which false memories correspondingly predict attachment anxiety. Moreover, it is possible that false memories (e.g., of negative experiences) and their consequents (e.g., fights about who said what to whom) may be mechanisms linking attachment anxiety to important outcomes, including reduced relationship satisfaction (Mikulincer & Shaver, 2016). Clearly, there are many important questions pertaining to attachment-driven false memories for future research to explore.

What Mechanisms Link Attachment Anxiety to False Memories?

One limitation of the present research is that—although our findings suggest that attachment anxiety causes false memories during encoding by biasing and desensitizing people's memories—we did not explore more-specific mechanisms via which false memories might be created. Future research should identify and explore potential factors that might link attachment anxiety to false memories. As an analog, previous research using cognitive methodologies has suggested that the links between attachment avoidance and errors of *omission* are because of motivated processes: highly avoidant individuals actively ignore relational stimuli and fail to encode them into memory and also appear to engage in effortful suppression of stored relational memories (Edelstein, 2006; Fraley & Brumbaugh, 2007; Fraley, Davis, & Shaver, 1998; Fraley, Garner, et al., 2000; Mikulincer & Orbach, 1995). Researchers might use similar cognitive methods to determine mechanisms through which attachment anxiety is related to false memories. For example, if attachment anxiety is related to false memories because highly anxious individuals attend more to cues for rejection (Chris Fraley et al., 2006) at the expense of other details (thereby biasing and desensitizing their memories), false memories should be more prevalent among highly anxious individuals for lab stimuli that are explicitly designed to contain many distracting rejection cues alongside the target material, as opposed to for lab stimuli designed to contain as few rejection cues as is possible alongside the target material.

Other Limitations

Another limitation of the present studies is that we only examined false memories in the context of recognition memory tasks. Although recognition tasks are frequently used to study false memories (e.g., Ein-Dor et al., 2011; Straube, 2012; Wilson, 2006; Zhu et al., 2010), false memories are a broader phenomenon that can also include confabulating inaccurate information in free-recall contexts. Unfortunately, however, our data cannot speak to whether attachment anxiety might also predict false memories in less structured tasks, such as free recall. Future research should examine the extent to which attachment anxiety also predicts false memories using potentially more ecologically valid paradigms, including recall tasks or daily diary studies (e.g., McWilliams et al., 2014).

Relatedly, we theorized that attachment anxiety should most strongly predict false memories for stimuli that are relational in nature—and not necessarily false memories more broadly. Thus, all of the memory stimuli in our studies pertained to relationships. Moreover, our stimuli were limited to a word list (Study 1) and one video (Studies 2–5). Future research should directly test the extent to which attachment anxiety-related false memories occur in other domains and/or with other stimuli. For example, scholars might examine whether attachment anxiety predicts false memories for non-relational information—including basic factual information.

An additional limitation of our studies is that the time delay between presentation of the memory stimuli and the administration of the recognition test varied across the studies (from no delay [Studies 1 and 2], to a two-day delay [Studies 3 and 4], to a roughly 20-minutes delay [Study 5]). Irrespective of these differences in delay, high levels of *trait* attachment anxiety consistently predicted more numerous false alarms—and the magnitude of effect was remarkably consistent across all five studies. In other words, highly trait-anxious people experienced more numerous false alarms—and to a similar extent—irrespective of whether they had seen the stimuli immediately before the memory test, or up to two days prior.

In contrast, experimentally inducing high state levels of attachment anxiety produced more numerous false alarms in only Study 5, which had a short delay between presentation of the stimuli and administration of the memory test—but not in Studies 3 or 4, which entailed much longer, multiple-day delays between the stimuli and test. Thus, it may be the case that rather than influencing encoding (vs. maintenance or retrieval), experimentally induced high state levels of attachment anxiety actually caused people to experience false memories for *recent* events in Study 5 (vs. more temporally *distal* ones in Studies 3 through 4). Seemingly arguing against this possibility is the fact that previous research suggests that attachment-related memory biases grow *stronger* over time (e.g., Simpson et al., 2010) and that, in the present studies, *trait* attachment anxiety predicted false alarms to a similar extent, irrespective of delay (and, thus, it is unclear why

manipulating state attachment anxiety should defy both of these findings and more strongly promote false memories for recent events vs. more distal ones). Nevertheless, although we believe that our findings are most consistent with the idea that high levels of attachment anxiety spur false memories during encoding, we cannot soundly rule out the possibility that differences in the results of Studies 3–5 are attributable to the shorter timeframe in Study 5.

Relatedly, one final limitation of our studies is that we were unable to rule out the idea that attachment orientations may produce false memories during maintenance over extended periods of time. In Study 4, we tested one specific maintenance process—whether reflecting on the video contents for several minutes while in an experimentally induced state of high attachment anxiety might corrupt the existing memories and produce false memories. Although this procedure did not produce an immediate gain in false memories, it may be the case that repeatedly administering attachment primes before asking participants to reflect on the video could educe false memories over an extended period of time (e.g., Simpson et al., 2010). It may also be the case that a single priming session is sufficient to bias existing memory traces, but the effect might only be manifest after an extended time delay (e.g., several days) rather than immediately.

Conclusion

It is relatively common for people to differ in their recollections of shared experiences. The present studies replicate existing research, which shows that highly anxious people are more likely than others to create false memories about interpersonal experiences—at least in the context of a recognition task. Moreover, it extends this work by tentatively showing that (a) experimental manipulations of attachment anxiety can influence false memory rates and (b) that they appear to do so by affecting the way in which information is processed during the encoding of events. Given, however, that a security prime may or may not have produced similar results to the anxiety prime, future research must explore the precise mechanisms through which anxiety primes produce false memories.

References

Baldwin, M. W., Keelan, J. P. R., Fehr, B., Enns, V., & Koh-Rangarajoo, E. (1996). Social-cognitive conceptualization of attachment working models: Availability and accessibility effects. *Journal of Personality and Social Psychology, 71,* 94–109. http://dx.doi.org/10.1037/0022-3514.71.1.94

Bartholomew, K., & Horowitz, L. M. (1991). Attachment styles among young adults: A test of a four-category model. *Journal of Personality and Social Psychology, 61,* 226–244. http://dx.doi.org/10.1037/0022-3514.61.2.226

Brainerd, C. J., & Reyna, V. F. (2002). Fuzzy-trace theory and false memory. *Current Directions in Psychological Science, 11,* 164–169. http://dx.doi.org/10.1111/1467-8721.00192

Brennan, K. A., Clark, C. L., & Shaver, P. R. (1998). Self-report measurement of adult attachment: An integrative overview. In J. A. Simpson & W. S. Rholes (Eds.), *Attachment theory and close relationships* (pp. 46–76). New York, NY: Guilford Press.

Carnelley, K. B., & Rowe, A. C. (2007). Repeated priming of attachment security influences later views of self and relationships. *Personal Relationships, 14,* 307–320. http://dx.doi.org/10.1111/j.1475-6811.2007.00156.x

Carnelley, K. B., & Rowe, A. C. (2010). Priming a sense of security: What goes through people's minds? *Journal of Social and Personal Relationships, 27,* 253–261. http://dx.doi.org/10.1177/0265407509360901

Chris Fraley, R., & Brumbaugh, C. C. (2007). Adult attachment and preemptive defenses: Converging evidence on the role of defensive exclusion at the level of encoding. *Journal of Personality, 75,* 1033–1050. http://dx.doi.org/10.1111/j.1467-6494.2007.00465.x

Chris Fraley, R., Niedenthal, P. M., Marks, M., Brumbaugh, C., & Vicary, A. (2006). Adult attachment and the perception of emotional expressions: Probing the hyperactivating strategies underlying anxious attachment. *Journal of Personality, 74,* 1163–1190. http://dx.doi.org/10.1111/j.1467-6494.2006.00406.x

Clancy, S. A., McNally, R. J., Schacter, D. L., Lenzenweger, M. F., & Pitman, R. K. (2002). Memory distortion in people reporting abduction by aliens. *Journal of Abnormal Psychology, 111,* 455–461. http://dx.doi.org/10.1037/0021-843X.111.3.455

Collins, N. L., Guichard, A. C., Ford, M. B., & Feeney, B. C. (2004). Working models of attachment. New developments and emerging themes. In W. S. Rholes & J. A. Simpson (Eds.), *Adult attachment: Theory, research, and clinical implications* (pp. 196–239). New York, NY: Guilford Press.

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review, 93,* 283–321. http://dx.doi.org/10.1037/0033-295X.93.3.283

Dobbins, I. G., Khoe, W., Yonelinas, A. P., & Kroll, N. E. (2000). Predicting individual false alarm rates and signal detection theory: A role for remembering. *Memory & Cognition, 28,* 1347–1356. http://dx.doi.org/10.3758/BF03211835

Dunlop, P. D., Telford, A. D., & Morrison, D. L. (2012). Not too little, but not too much: The perceived desirability of responses to personality items. *Journal of Research in Personality, 46,* 8–18. http://dx.doi.org/10.1016/j.jrp.2011.10.004

Dykas, M. J., Woodhouse, S. S., Ehrlich, K. B., & Cassidy, J. (2010). Do adolescents and parents reconstruct memories about their conflict as a function of adolescent attachment? *Child Development, 81,* 1445–1459. http://dx.doi.org/10.1111/j.1467-8624.2010.01484.x

Dykas, M. J., Woodhouse, S. S., Ehrlich, K. B., & Cassidy, J. (2012). Attachment-related differences in perceptions of an initial peer interaction emerge over time: Evidence of reconstructive memory processes in adolescents. *Developmental Psychology, 48,* 1381–1389. http://dx.doi.org/10.1037/a0027462

Edelstein, R. S. (2006). Attachment and emotional memory: Investigating the source and extent of avoidant memory impairments. *Emotion, 6,* 340–345. http://dx.doi.org/10.1037/1528-3542.6.2.340

Edelstein, R. S., Ghetti, S., Quas, J. A., Goodman, G. S., Alexander, K. W., Redlich, A. D., & Cordón, I. M. (2005). Individual differences in emotional memory: Adult attachment and long-term memory for child sexual abuse. *Personality and Social Psychology Bulletin, 31,* 1537–1548. http://dx.doi.org/10.1177/0146167205277095

Ein-Dor, T., Mikulincer, M., & Shaver, P. R. (2011). Attachment insecurities and the processing of threat-related information: Studying the schemas involved in insecure people's coping strategies. *Journal of Personality and Social Psychology, 101,* 78–93. http://dx.doi.org/10.1037/a0022503

Feeney, B. C., & Cassidy, J. (2003). Reconstructive memory related to adolescent-parent conflict interactions: The influence of attachment-related representations on immediate perceptions and changes in perceptions over time. *Journal of Personality and Social Psychology, 85,* 945–955. http://dx.doi.org/10.1037/0022-3514.85.5.945

Fraley, R. C., & Davis, K. E. (1997). Attachment formation and transfer in young adults' close friendships and romantic relationships. *Personal Relationships, 4,* 131–144. http://dx.doi.org/10.1111/j.1475-6811.1997.tb00135.x

Fraley, R. C., Davis, K. E., & Shaver, P. R. (1998). Dismissing-avoidance and the defensive organization of emotion, cognition, and behavior. In J. A. Simpson & W. S. Rholes (Eds.), *Attachment theory and close relationships* (pp. 249–279). New York, NY: Guilford Press.

Fraley, R. C., Garner, J. P., & Shaver, P. R. (2000). Adult attachment and the defensive regulation of attention and memory: Examining the role of preemptive and postemptive defensive processes. *Journal of Personality and Social Psychology, 79,* 816–826. http://dx.doi.org/10.1037/0022-3514.79.5.816

Fraley, R. C., Heffernan, M. E., Vicary, A. M., & Brumbaugh, C. C. (2011). The Experiences in Close Relationships-Relationship Structures questionnaire: A method for assessing attachment orientations across relationships. *Psychological Assessment, 23,* 615–625. http://dx.doi.org/10.1037/a0022898

Fraley, R. C., Hudson, N. W., Heffernan, M. E., & Segal, N. (2015). Are adult attachment styles categorical or dimensional? A taxometric analysis of general and relationship-specific attachment orientations. *Journal of Personality and Social Psychology, 109,* 354–368. http://dx.doi.org/10.1037/pspp0000027

Fraley, R. C., & Shaver, P. R. (2000). Adult romantic attachment: Theoretical developments, emerging controversies, and unanswered questions. *Review of General Psychology, 4,* 132–154. http://dx.doi.org/10.1037/1089-2680.4.2.132

Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An item response theory analysis of self-report measures of adult attachment. *Journal of Personality and Social Psychology, 78,* 350–365. http://dx.doi.org/10.1037/0022-3514.78.2.350

Gillath, O., Karantzas, G., & Fraley, R. C. (2016). *Adult attachment: A concise guide to theory and research*. New York, NY: Academic Press.

Gillath, O., Mikulincer, M., Fitzsimons, G. M., Shaver, P. R., Schachner, D. A., & Bargh, J. A. (2006). Automatic activation of attachment-related goals. *Personality and Social Psychology Bulletin, 32,* 1375–1388. http://dx.doi.org/10.1177/0146167206290339

Gillath, O., Selcuk, E., & Shaver, P. R. (2008). Moving toward a secure attachment style: Can repeated security priming help? *Social and Personality Psychology Compass, 2,* 1651–1666. http://dx.doi.org/10.1111/j.1751-9004.2008.00120.x

Gillath, O., Sesko, A. K., Shaver, P. R., & Chun, D. S. (2010). Attachment, authenticity, and honesty: Dispositional and experimentally induced security can reduce self- and other-deception. *Journal of Personality and Social Psychology, 98,* 841–855. http://dx.doi.org/10.1037/a0019206

Goodman, G. S., Ogle, C. M., Block, S. D., Harris, L. S., Larson, R. P., Augusti, E.-M., . . . Urquiza, A. (2011). False memory for trauma-related Deese-Roediger-McDermott lists in adolescents and adults with histories of child sexual abuse. *Development and Psychopathology, 23,* 423–438. http://dx.doi.org/10.1017/S0954579411000150

Gosling, S. D., Rentfrow, P. J., & Swann, W. B., Jr. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37,* 504–528. http://dx.doi.org/10.1016/S0092-6566(03)00046-1

Grau, I., & Doll, J. (2003). Effects of attachment styles on the experience of equity in heterosexual couples relationships. *Experimental Psychology, 50,* 298–310. http://dx.doi.org/10.1026//1618-3169.50.4.298

Haggerty, G. D., Siefert, C. J., & Weinberger, J. (2010). Examining the relationship between current attachment status and freely recalled autobiographical memories of childhood. *Psychoanalytic Psychology, 27,* 27–41. http://dx.doi.org/10.1037/a0018638

Hazan, C., & Shaver, P. (1987). Romantic love conceptualized as an attachment process. *Journal of Personality and Social Psychology, 52,* 511–524. http://dx.doi.org/10.1037/0022-3514.52.3.511

Hudson, N. W., & Fraley, R. C. (2016). Do people's desires to change their personality traits vary with age? An examination of trait change goals across adulthood. *Social Psychological & Personality Science, 7,* 847–856.

Hudson, N. W., Fraley, R., Chopik, W. J., & Heffernan, M. E. (2015). Not all attachment relationships develop alike: Normative cross-sectional age trajectories in attachment to romantic partners, best friends, and parents. *Journal of Research in Personality, 59,* 44–55. http://dx.doi.org/10.1016/j.jrp.2015.10.001

Hudson, N. W., & Roberts, B. W. (2014). Goals to change personality traits: Concurrent links between personality traits, daily behavior, and goals to change oneself. *Journal of Research in Personality, 53,* 68–83. http://dx.doi.org/10.1016/j.jrp.2014.08.008

John, O. P., & Srivastava, S. (1999). The Big-Five trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 102–138). New York, NY: Guilford Press.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114,* 3–28. http://dx.doi.org/10.1037/0033-2909.114.1.3

Jou, J., & Flores, S. (2013). How are false memories distinguishable from true memories in the Deese-Roediger-McDermott paradigm? A review of the findings. *Psychological Research, 77,* 671–686. http://dx.doi.org/10.1007/s00426-012-0472-6

Kish, L. (1965). *Survey sampling*. New York, NY: Wiley.

Kohn, J. L., Rholes, W. S., & Schmeichel, B. J. (2012). Self-regulatory depletion and attachment avoidance: Increasing the accessibility of negative attachment-related memories. *Journal of Experimental Social Psychology, 48,* 375–378. http://dx.doi.org/10.1016/j.jesp.2011.06.020

Loftus, E. F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior, 13,* 585–589. http://dx.doi.org/10.1016/S0022-5371(74)80011-3

Loftus, E. F., & Pickrell, J. E. (1995). The formation of false memories. *Psychiatric Annals, 25,* 720–725. http://dx.doi.org/10.3928/0048-5713-19951201-07

Luke, M. A., Sedikides, C., & Carnelley, K. (2012). Your love lifts me higher! The energizing quality of secure relationships. *Personality and Social Psychology Bulletin, 38,* 721–733. http://dx.doi.org/10.1177/0146167211436117

Macmillan, N. A., & Creelman, C. D. (1991). *Detection theory: A user's guide*. New York, NY: Cambridge University Press.

McClure, M. J., Bartz, J. A., & Lydon, J. E. (2013). Uncovering and overcoming ambivalence: The role of chronic and contextually activated attachment in two-person social dilemmas. *Journal of Personality, 81,* 103–117. http://dx.doi.org/10.1111/j.1467-6494.2012.00788.x

McWilliams, K., Goodman, G. S., Lyons, K. E., Newton, J., & Avila-Mora, E. (2014). Memory for child sexual abuse information: Simulated memory error and individual differences. *Memory & Cognition, 42,* 151–163. http://dx.doi.org/10.3758/s13421-013-0345-2

Mikulincer, M., Gillath, O., Halevy, V., Avihou, N., Avidan, S., & Eshkoli, N. (2001). Attachment theory and reactions to others' needs:' evidence that activation of the sense of attachment security promotes empathic responses. *Journal of Personality and Social Psychology, 81,* 1205–1224. http://dx.doi.org/10.1037/0022-3514.81.6.1205

Mikulincer, M., & Orbach, I. (1995). Attachment styles and repressive defensiveness: The accessibility and architecture of affective memories. *Journal of Personality and Social Psychology, 68,* 917–925. http://dx.doi.org/10.1037/0022-3514.68.5.917

Mikulincer, M., & Shaver, P. R. (2016). *Attachment in adulthood: Structure, dynamics, and change*. New York, NY: Guilford Press.

Mikulincer, M., Shaver, P. R., Gillath, O., & Nitzberg, R. A. (2005). Attachment, caregiving, and altruism: Boosting attachment security increases compassion and helping. *Journal of Personality and Social Psychology, 89,* 817–839. http://dx.doi.org/10.1037/0022-3514.89.5.817

Miller, J. B. (2001). Attachment models and memory for conversation. *Journal of Social and Personal Relationships, 18,* 404–422. http://dx.doi.org/10.1177/0265407501183006

Miller, J. B., & Noirot, M. (1999). Attachment memories, models and information processing. *Journal of Social and Personal Relationships, 16,* 147–173. http://dx.doi.org/10.1177/0265407599162002

Park, L. E. (2007). Appearance-based rejection sensitivity: Implications for mental and physical health, affect, and motivation. *Personality and Social Psychology Bulletin, 33,* 490–504. http://dx.doi.org/10.1177/0146167206296301

Pereg, D., & Mikulincer, M. (2004). Attachment style and the regulation of negative affect: Exploring individual differences in mood congruency effects on memory and judgment. *Personality and Social Psychology Bulletin, 30,* 67–80. http://dx.doi.org/10.1177/0146167203258852

Richard, F. D., Bond, C. F., & Stokes-Zoota, J. J. (2003). One hundred years of social psychology quantitatively described. *Review of General Psychology, 7,* 331–363. http://dx.doi.org/10.1037/1089-2680.7.4.331

Selterman, D. F., & Maier, M. A. (2013). Secure attachment and material reward both attenuate romantic jealousy. *Motivation and Emotion, 37,* 765–775. http://dx.doi.org/10.1007/s11031-013-9340-y

Simpson, J. A., Rholes, W. S., & Winterheld, H. A. (2010). Attachment working models twist memories of relationship events. *Psychological Science, 21,* 252–259. http://dx.doi.org/10.1177/0956797609357175

Stadler, M. A., Roediger, H. L., III, & McDermott, K. B. (1999). Norms for word lists that create false memories. *Memory & Cognition, 27,* 494–500. http://dx.doi.org/10.3758/BF03211543

Straube, B. (2012). An overview of the neuro-cognitive processes involved in the encoding, consolidation, and retrieval of true and false memories. *Behavioral and Brain Functions, 8,* 35. http://dx.doi.org/10.1186/1744-9081-8-35

Wagner, U., Gais, S., Haider, H., Verleger, R., & Born, J. (2004). Sleep inspires insight. *Nature, 427,* 352–355. http://dx.doi.org/10.1038/nature02223

Wei, M., Russell, D. W., Mallinckrodt, B., & Vogel, D. L. (2007). The Experiences in Close Relationship Scale (ECR)-short form: Reliability, validity, and factor structure. *Journal of Personality Assessment, 88,* 187–204. http://dx.doi.org/10.1080/00223890701268041

Wilson, C. L. (2006). *Attachment working models and false recall: A category structure approach*. Texas A&M University. Retrieved from http://repository.tamu.edu/bitstream/handle/1969.1/ETD-TAMU-1857/WILSON-DISSERTATION.pdf?sequence=1

Woodhouse, S. S., & Gelso, C. J. (2008). Volunteer client adult attachment, memory for in-session emotion, and mood awareness: An affect regulation perspective. *Journal of Counseling Psychology, 55,* 197–208. http://dx.doi.org/10.1037/0022-0167.55.2.197

Wright, D. B., Busnello, R. H. D., Buratto, L. G., & Stein, L. M. (2012). Are valence and social avoidance associated with the memory conformity effect? *Acta Psychologica, 141,* 78–85. http://dx.doi.org/10.1016/j.actpsy.2012.06.008

Wright, D. B., & Loftus, E. F. (1998). How misinformation alters memories. *Journal of Experimental Child Psychology, 71,* 155–164. http://dx.doi.org/10.1006/jecp.1998.2467

Wright, D. B., London, K., & Waechter, M. (2010). Social anxiety moderates memory conformity in adolescents. *Applied Cognitive Psychology, 24,* 1034–1045. http://dx.doi.org/10.1002/acp.1604

Zaragoza, M. S., Mitchell, K. J., Payment, K., & Drivdahl, S. (2011). False memories for suggestions: The impact of conceptual elaboration. *Journal of Memory and Language, 64,* 18–31. http://dx.doi.org/10.1016/j.jml.2010.09.004

Zeijlmans van Emmichoven, I. A., van IJzendoorn, M. H., de Ruiter, C., & Brosschot, J. F. (2003). Selective processing of threatening information: Effects of attachment representation and anxiety disorder on attention and memory. *Development and Psychopathology, 15,* 219–237. http://dx.doi.org/10.1017/S0954579403000129

Zhu, B., Chen, C., Loftus, E. F., Lin, C., He, Q., Chen, C., . . . Dong, Q. (2010). Individual differences in false memory from misinformation: Personality characteristics and their interactions with cognitive abilities. *Personality and Individual Differences, 48,* 889–894. http://dx.doi.org/10.1016/j.paid.2010.02.016

(*Appendix follows*)

Appendix

Table A1
Mean Raw False Alarm Rates by Condition

Study	Control group	Anxiety prime	Security prime	Overall
1	—	—	—	37.80%
2	—	—	—	16.51%
3	34.93%	33.33%	32.54%	33.59%
4	31.61%	32.67%	32.69%	32.32%
5	22.04%	26.14%	24.49%	24.24%

Table A2
Mean Raw Hit Rates by Condition

Study	Control group	Anxiety prime	Security prime	Overall
1	—	—	—	83.85%
2	—	—	—	76.78%
3	74.29%	75.46%	74.71%	74.82%
4	75.19%	76.02%	75.15%	75.44%
5	79.72%	77.79%	77.80%	78.43%

Table A3
Mean Endorsement of Individual Memory Test Items and Correlations With Trait Anxiety (Studies 1–2) or the Anxiety Prime (Studies 3–5)

M	$r_{anxiety}$	Item text
		Study 1
True items		
.67	.06	Unwanted
.79	.05	Possessive
.83	.04	Loveable
.94	.04	Clingy
.77	.03	Worthy
.76	.03	Empty
.86	.03	Unaccepted
.86	.03	Unworthy
.87	.02	Supportive
.85	.02	Forgotten
.93	.01	Abandoned
.89	.01	Burdensome
.85	.01	Outcast
.70	.01	Distressed
.85	.01	Inadequate
.79	−.01	Treasured
.79	−.01	Fearful
.90	−.01	Needy

(*Appendix continues*)

Table A3 (*continued*)

M	$r_{anxiety}$	Item text
.81	−.01	Unsafe
.89	−.02	Affectionate
.87	−.02	Appreciated
.84	−.02	Comfortable
.70	−.02	Close
.68	−.02	Exploring
.81	−.02	Independent
.83	−.02	Reliable
.80	−.02	Safe
.82	−.02	Valued
.84	−.02	Warm
.88	−.02	Dependent
.89	−.03	Autonomous
.82	−.03	Open
.85	−.03	Bad
.71	−.03	Pleading
.80	−.04	Intimate
.77	−.06	Trusting
False items		
.49	.05	Accepted
.28	.04	Alone
.65	.03	Supported
.03	.03	Unafraid
.27	.03	Demanding
.23	.02	Protected
.39	.02	Unlovable
.27	.01	Desirable
.58	.01	Insecure
.37	.01	Rejected
.29	.00	Wanted
.66	.00	Undesirable
.29	−.01	Capable
.89	−.01	Neglected
.39	−.02	Secure
.09	−.04	Forsaken
		Study 2
True items		
.78	.12	Victoria said that James was involved in planning their wedding.
.54	.10	Victoria said that she felt useless and hopeless in her relationship with James.
.57	.09	Victoria said that even after James stopped drinking, she still didn't feel like she clicked or connected with him.
.79	.07	Victoria said that she and James "really knew each other's history."
.88	.05	Victoria said that she took a brief break from dating James, dated another man, but ultimately chose James.
.88	.05	According to Victoria, it was unusual for her and James to go even two days without talking.
.68	.05	Victoria said that she sent James packages in the mail to show him she cared for him.
.95	.05	According to Victoria, James told her that she should kill herself.
.81	.04	Victoria said that after she and James broke up, she continued to call and text him all of the time.
.44	.02	Victoria said that James mailed her stuffed animals while they were dating.
.70	.02	Victoria said that James was the "epitome of everything that [she] hates."
.89	.02	Victoria called James "not a real man."
.62	.01	Victoria said that her and James's relationship was very passionate.
.71	.01	Victoria said that she "basically ruined everything all of the time because [she] was crazy."
.84	.00	Victoria said that she was willing to share blame with James for their relationship failing.
.53	.00	Victoria said that she wasn't trustworthy, loyal, or compassionate while dating James.

(*Appendix continues*)

Table A3 (*continued*)

M	$r_{anxiety}$	Item text
.94	.00	According to Victoria, James told her via text message that he had cheated on her.
.99	−.01	James asked Victoria to marry him.
.88	−.02	According to Victoria, while she and James dated, they talked nearly every day.
.94	−.02	According to Victoria, James called her a "stupid bitch."
.69	−.03	According to Victoria, for most of their relationship, she and James were close.
.64	−.03	Victoria said she DID regret her negative actions after she and James broke up
.51	−.05	Victoria said she did NOT regret her negative actions after she and James broke up.
.91	−.06	Victoria said that she believed that she was not the best girlfriend in the world.
.83	−.06	Victoria said that she expected James to cheat on her, even before he did.
.90	−.07	Victoria said that James wanted to make a deeper commitment to her.
.79	−.07	Victoria said that she felt that James lied to her about what he could and couldn't remember while he was drunk.
.85	−.08	Victoria burned all of the gifts that James had mailed her.
False items		
.13	.18	Victoria said that James "only occasionally got drunk, and when he wasn't drunk, he was a great guy."
.27	.12	Victoria said that James wouldn't get as emotionally close as she wanted to be.
.03	.11	Victoria said that she stole James's property to get back at him.
.50	.11	Victoria said that James wasn't there for her emotionally when she needed him.
.29	.08	Victoria said that she thought James was particularly handsome.
.11	.06	Victoria said that, before he cheated on her, James was very emotionally supportive.
.60	.05	Victoria said that, at the beginning of their relationship, James was very physically and verbally affectionate with her.
.03	.05	Victoria said that she believes James is 100% responsible for their break-up.
.03	.05	Victoria said that James told her that he didn't want to help plan the wedding.
.08	.05	According to Victoria, James was bad at communicating and frequently wouldn't take her phone calls.
.36	.04	According to Victoria, James told her that he would never leave her.
.06	.04	According to Victoria, James got drunk and physically hit her.
.03	.04	Victoria said that she was afraid of James.
.02	.03	Victoria said that she only stayed with James because she had no other options.
.32	.03	According to Victoria, after James promised her that he wouldn't cheat on her again, he cheated a second time.
.04	.02	According to Victoria, after cheating on her, James bought her flowers and gifts.
.48	−.01	Victoria said that she and James were in love.
.03	−.03	According to Victoria, while they dated, James went to the doctor with her to support her.
.08	−.03	Victoria said that she hated hearing about James's problems and wanted him to solve them on his own.
.05	−.04	Victoria said that James was angry with her for getting ovarian cancer.
.02	−.05	Victoria said that she never really loved James.
.08	−.10	According to Victoria, James told her that he didn't love her.
		Studies 3–5*
True items		
.92	.09	According to Victoria, James said that he wanted to make a deeper commitment to her.
.67	.06	Victoria said that, while dating James, she basically ruined everything all of the time because she was crazy.
.51	.06	Victoria said that she felt useless and hopeless in her relationship with James.
.91	.05	According to Victoria, she and James broke up and got back together once, before he cheated on her.
.88	.04	Victoria said she felt that James lied to her about what he could and couldn't remember while drunk.
.92	.04	Victoria burned all of the gifts that James had mailed her.
.69	.03	Victoria said that James mailed her stuffed animals and letters while they were dating.
.89	.03	According to Victoria, while she and James dated, they spent nearly every day talking.

(*Appendix continues*)

Table A3 (*continued*)

M	$r_{anxiety}$	Item text
.93	.02	Victoria said that, at one point, her relationship with James was very pleasant.
.97	.02	According to Victoria, James called her a "stupid bitch."
.85	.02	According to Victoria, James once promised that he would never cheat on her, but broke that promise.
.92	.02	According to Victoria, James told her via text message that he had cheated on her.
.70	.00	Victoria said that her and James's relationship was very passionate.
.93	.00	Victoria said that she was not surprised that James cheated on her.
.90	.00	According to Victoria, after she and James broke up, she had trouble letting go and continued to call and text him.
.60	.00	Victoria said she DID regret her actions after she and James broke up.
.88	−.01	Victoria said that her relationship with James was very serious.
.91	−.02	Victoria called James, "not a real man."
.95	−.04	According to Victoria, James told her she should kill herself.
.56	−.04	Victoria said she did NOT regret her actions after she and James broke up.
.81	−.07	According to Victoria, James helped to plan some of the details of their wedding.
.32	−.07	Victoria said that she wasn't trustworthy or loyal while she dated James.
.75	−.07	Victoria said that she was devastated when James cheated on her.
.63	−.13	According to Victoria, after learning that James cheated on her, she was more mad at herself than at him.
.47	−.14	Victoria said that while she was dating James, she generally didn't care about other people's feelings.
.93	−.16	Victoria said that she and James were very close.
False items		
.44	.18	Victoria said that James told her that he would never abandon her.
.08	.13	Victoria said that James usually kept his promises to her, which made it surprising when he cheated.
.52	.12	Victoria said that, even through the highs and lows, she always expected the best for her and James' relationship.
.13	.11	Victoria said that James took full responsibility for his negative actions, and tried to make amends.
.44	.08	According to Victoria, James was usually responsible and caring, except when he was drunk.
.01	.08	Victoria said that while they dated, James went to the doctor with her to support her.
.12	.07	Victoria said that James was very passionate and occasionally bought her flowers.
.11	.07	Victoria said that James was uninvolved in planning any of the details of their wedding.
.13	.05	According to Victoria, she and James were never particularly passionate with one another.
.49	.05	Victoria said that she thought James was the love of her life.
.31	.05	Victoria said that she and James were very interdependent with each other.
.11	.04	Victoria said that James frequently ignored her phone calls while they were dating.
.45	.04	Victoria said that James had no self-control in any domain of his life.
.28	.03	According to Victoria, after James promised that he wouldn't cheat on her, he cheated a second time.
.22	.02	Victoria said that, before he cheated, she fully trusted James.
.40	.02	Victoria said that James was a relatively respectable and upstanding guy who was destroyed by his alcohol addiction.
.07	.02	According to Victoria, James got drunk and physically hit her.
.31	.01	Victoria said that she felt that she was a very good girlfriend to James.
.24	.01	Victoria said that James was deliberate to a fault, and sometimes he could be too particular and controlling.
.12	.01	Victoria said that James promised to buy her a wedding dress, but broke that promise.
.09	.00	Victoria said that James was angry with her for having cancer.
.25	.00	Victoria said that she was very controlling and overbearing while dating James.
.52	−.01	Victoria said that, after James cheated on her, she felt numb and devoid of emotions.
.14	−.05	Victoria said that she loved James's spontaneity.
.09	−.09	Victoria said that James was sometimes too needy in their relationship.

* Statistics are from Study 5.

Received February 15, 2016
Revision received April 20, 2018
Accepted May 23, 2018 ■